Semi-Annual Report

January - June

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NATURAL RESOURCES RESEARCH INSTITUTE

Our research goes to work.

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Project Highlights

CENTER FOR APPLIED RESEARCH & TECHNOLOGY DEVELOPMENT

Wood Products and Forestry

NRRI Poplar Genetics Program Clones Scheduled for Commercial Plantations in 2012

The poplar genetics program at NRRI has been involved in a large breeding and field testing program for the past decade. New clones resulting from our genetics improvement program will be planted in commercial plantations for the first time in 2012. This represents a major accomplishment for our breeding program.

Heating the Midwest with Renewable Biomass

NRRI Wood Materials and Manufacturing Program Director, Brian Brashaw, has taken a leadership role in the "Heating the Midwest," a grass roots effort aimed at developing a vision and implementing increasing use of renewable biomass for thermal heating applications. Heating the Midwest is a group of volunteers from more than 50 Midwest regional organization representatives from industry, government agencies, nonprofit organizations, and universities. The group's mission is: "To advance biomass thermal heating in the Midwest for a more sustainable future while improving the economic, environmental and social well-being of the region." Brian served as one of the coordinators of a February 2011 summit held in Carlton, Minnesota, serves on the steering committee, initiated the formation of a committee focused on policy, and will be serving as a co-chair of the inaugural "Heating the Midwest with Renewable Biomass Conference" to be held in Eau Claire, Wisconsin, April 25-27, 2012.

Beijing Forestry University, Beijing, China

NRRI Wood Materials and Manufacturing Program Director, Brian Brashaw, participated in a one-week research overview and planning session held in Beijing, China during February 2011. In cooperation with the Beijing Forestry University and the Beijing Cultural Heritage Administration, the focus was to help support nondestructive research and assessment of historic timber structures in Beijing. This includes noted historic locations such as the Forbidden City, the Summer Palace, and the Ming Tombs. During this effort, he provided key scientific review of research aimed at understanding the residual structural capacity of historic wood structures, as determined through nondestructive assessment and evaluation.

Timber Bridge Inspection Workshops

Minnesota's Nobles County experienced a timber bridge failure in 2010, raising concerns among city, county, and state engineers about the current practice of timber bridge inspections. Typically, inspections for timber bridges have been mostly limited to visual inspection, hammer sounding, and probing. In an effort to improve the understanding of new advanced nondestructive evaluation techniques, NRRI Wood Materials and Manufacturing Program Director, Brian Brashaw, conducted training at six Minnesota locations as part of the 2011 Annual Bridge Inspector Training coordinated by the Minnesota Department of Transportation. These training presentations were key in helping Minnesota inspectors and engineers understand potential techniques and equipment for conducting inspections. Implementation of these approaches will prevent bridge failures such as the Nobles County Bridge and provide key information that can be used to develop rehabilitation strategies which result in increased service life.

International Wood Treating Group from Denmark Visits NRRI Forest Products Staff

The Forest Products Group was visited by a European wood treating technology group, International Wood Treating, from Denmark. The visit included the Managing Director, Mr. Bror Moldrup. International Wood Treating has proposed providing NRRI a laboratory-scale thermal-modification kiln in partnership with the Wisconsin Business Innovation Corporation.

Energy

Geothermal Heat Flow Mapping Study

During this period, we had another equipment failure with the downhole temperature probe. The decision was made to order our own downhole probe, which was subsequently purchased from Mt. Sophris Instruments in Colorado. Unlike previous equipment, the new instrument is entirely digital and controlled by computer. NRRI's Economic Geology Group personnel, along with two UMD students, have completed temperature sampling in a total of 49 water wells/exploration drill holes. Geochemistry on the granite samples has indicated a few samples with elevated whole rock, uranium and thorium (in parts per million (ppm)). Additional radionuclide analyses on potassium, uranium, and thorium will be completed at UND-Grand Forks during the next period. Thermal conductivity (how fast heat moves through different rocks) was also completed, and the first thermal conductivity map of Minnesota was produced along with a new heat flow map. The result of this work has shown that the warmer rocks are closer to the surface than previous maps indicated. According to Ph. D. student Robert Klenner at UND-Grand Forks, "The estimated mean heat flow for the region was raised from 40 mWm-2 to 45 mWm-2, an increase of 12%. These values are very similar to those obtained from measurements taken in Manitoba and Ontario, Canada, in the same Superior Subprovinces (Perry et al., 2006). Although heat flow values are still lower than the continental average, the 12% increase in heat flow has a positive effect on the potential development of EGS [Enhanced Geothermal System] projects in Minnesota (Klenner et al, submitted paper to the Geothermal Resource Council Bulletin)."

New Catalysts for Liquid Fuel Production

A group of novel mineral-based catalytic materials for conversion of Syngas to liquid fuels has been discovered at NRRI-CMRL. It was found that preparation of these catalysts is a labor-saving, cost effective, and easy scale-up technology. Systematic study proceeded on exploring properties of these catalysts in the Fischer-Tropsch Reaction and related processes at various conditions. Results of the complex research show the significant potential of these catalysts for thermochemical processing of renewable fuels.

Solid Fuel - Oxygen Fired Combustion for Production of Nodular Reduced Iron to Reduce CO_2 Emissions and Improve Energy Efficiencies

The focus of this program is on reducing the energy intensity and greenhouse gas emissions in a newly developed ironmaking process for production of nodular reduced iron (NRI). The process developed by NRRI uses a specialized linear hearth furnace (LHF) design. The furnace is currently equipped with an oxy-fuel combustion system with the potential to utilize solid fuel rather than natural gas for providing heat energy for reduction and smelting. When considering CO_2 capture, oxy-firing has the unique advantage to generate an effluent stream of the necessary purity for sequestration from this stream by simple water condensation. All combustion systems, fuel types (natural gas, coal and bio-char) and conditions have been tested. The present solid fuel combustion system uses an air swept eductor to convey the solid fuel, and with the current configuration, this system was prone to plugging. The relatively small size of the pilot LHF prevents the use of a larger diameter pipe to control solid fuel addition and minimize air contamination within the furnace. It is believed that a larger system on a more industrial scale would not exhibit this phenomenon; however, a dense phase conveyance system is desired to eliminate air contamination.

In box furnace tests, bio-char use as a reductant has indicated that fusion behavior using a biomass-derived carbon reductant resulted in significantly reducing fusion time over 30%, while reducing sulfur content of NRI to 0.020% - 0.035%. Prior results showed that a stoichiometric ratio of 85-95% fixed C:Fe was optimal for production of quality NRI at low sulfur concentration. Using biomass-prepared reductant at comparable stoichiometric ratios increased reductant carbon as a result of the high volatile matter, thereby increasing generation of micro NRI (-6 Mesh +20 Mesh fraction). Reducing the ratio to 75% resulted in decreasing the amount of micro NRI. Due to the relatively low fixed carbon level (25-30%) in bio-char, significant quantities were required to achieve the stoichiometric levels required. This reduced the density of briquettes by 30%, therefore reducing productivity of NRI. Using blends of bio-char with medium volatile bituminous coal at 10%, 30% and 50%, tests were conducted with significant results, reducing residence time requirements, and reducing sulfur content while increasing briquette density.

Environmental Remediation

Erie Pier Dredged Material Beneficial Use Study

Project work began in February, focusing on identification of potential recipient sites for small-scale near-term demonstrations, and for longer-term, larger-scale usage. NRRI's Economic Geology Group, largely through the efforts of Marsha Meinders Patelke, facilitated interactions and meetings with personnel from the City of Superior, and also the Wisconsin Departments of Natural Resources and Transportation during the spring of 2011. These discussions led to permits being obtained from MnDNR, WDNR, and St. Louis County, to allow approximately 1,000 cubic yards of fine-grain dredge materials from Erie Pier to be trucked to the Moccasin Mike Landfill in Superior, WI, to reestablish turf in an upland area disturbed during a sewer installation project. This material movement, which took place in early June, was a major milestone, because it marked the first time that any city in Wisconsin had been cleared to use and transport this kind of sediment across state lines. As part of this pilot project, the City of Superior is conducting a weed survey to identify any noxious weeds that may germinate in the sediment at the test site.

Minerals, Ferrous

Local Operational Research Assistance (OPERA) Program: "Taconite-enhanced pothole repair using portable microwave"

Goals of the OPERA project are to: 1) conduct laboratory testing on the most promising combinations of recycled asphalt pavement (RAP), taconite materials, and recycled asphalt shingles (RAS); and 2) conduct cold-weather (mid-winter) field testing at NRRI and at select locations in Anoka and St. Louis Counties using a mobile microwave unit. Field testing work will be done using mobile microwave equipment provided by Microwave Utilities, Inc., (MUI) of Monticello, MN.

The OPERA award was granted in early 2010, but significant delays were encountered in finalizing how the award would be set up and administered within the University system, and an actual budget number was not assigned to NRRI until the summer of 2010. Consequently, project work could not officially begin until a budget was available, and no cold-weather field testing was conducted in early 2010, as originally planned. However, on June 24, 2010, a preliminary pothole repair test using a blend of RAP and taconite aggregate materials was conducted at NRRI with MUI's mobile equipment. Cold-weather testing was rescheduled for winter-spring 2011 (February-March-April).

In November of 2010, arrangements were made through St. Louis County Engineer Jim Foldesi to acquire about 3 tons of RAP. With assistance from St. Louis County personnel, the granular (-3/4") RAP was loaded into three super sacks at the county's Pike Lake facility on December 3, 2010, and brought back to NRRI for future project use.

New Permanent University Trust Fund (PUTF) Project for Upgrading Iron Resources Found in Stockpiled Hematite Low Grade Ores on the Mesabi Iron Range

This research proposes to quantitate hematite iron resources found in stockpiled ore across the Mesabi Iron Range and to describe mineral processing and pyrometallurgical methods of upgrading these iron ores to produce value- added products. In a number of locations, stockpiled iron ores from previous mining operations have been shown to contain up to 45% total iron. Mineral processing techniques have been used to upgrade these hematite ores to greater than 60% total iron. In addition, natural-gas-based roasting techniques have been shown to convert hematite to magnetite, which can be upgraded using conventional low strength separator techniques. Processing flow sheets are being developed to describe various routes to convert the stockpiled hematite resources to products having commercial value.

Dust Reduction Project for Direct Reduced Iron (DRI) Operations

NRRI's Coleraine Minerals Research Laboratory was chosen by Nucor Steel to produce new DRI dust reduction techniques to reduce DRI dust generation at their Trinidad production facilities, as well as their U.S. electric arc furnace (EAF) steel-making operations using DRI as a partial recycled scrap steel replacement. Successful bench-scale dust reduction efforts have led to pilot scale demonstration projects for dust reduction at these Nucor facilities. One full-scale NRRI-developed dust reduction facility is being designed for installation at a Nucor EAF operation in Alabama.

Pot Grate Fired Pellet Simulator and Sinter Pot Simulator Completed at CMRL

The design, development, production, installation, and testing of a new state-of-the-art pot grate fired pellet furnace simulator and a new sinter pot simulator furnace were completed at the Coleraine Minerals Research Laboratory (CMRL). These furnace simulators are capable of producing fired pellets and sinter feed produced under firing conditions matching all straight grate and grate kiln taconite furnace operating conditions developed for worldwide pellet and sinter furnace operations.

Autogenous Grinding Mill Installed in CMRL Mineral Processing Pilot Plant

A 6ft x 3ft autogenous grinding mill is being installed at CMRL's mineral processing pilot plant to add to our grinding capabilities for concentrator flow sheet development in new iron ore and non-ferrous mining operations being planned throughout the world.

IREE (Initiative for Renewable Energy and the Environment) Solar Project

Several plasma furnace runs were completed to generate a sufficient number of plasma tiles out of taconite tailings to populate a 4.5 square meter solar air heater. A plasma furnace reline was required mid-project due to furnace lining wear. Also, a compressed air oil filter was added to the plasma system due to compressor oil migration down the air lines. A frame and stand for the 4.5 sq-m heater were also fabricated at CMRL. An air blower, thermocouples, and tempered glazing were obtained for the air heater. During summer months, the small-scale prototype heater demonstrated tile surface temperatures exceeding 180°F, with heat being extracted from the air cavity.

ERMADEN Concentrating and Pelletizing Process Flowsheet Development
Erdemir Mining Industry and Trade, Inc., (ERMADEN) is evaluating the opportunity to build a concentration and pelletizing facility to process ore from the Hasancelebi iron ore deposit. A bulk sample (approximately 33 tons) comprised of low-, medium- and high-grade ore and approximately 45 drill core samples was delivered to the Coleraine Minerals Research Laboratory from the Hekimhan district located 94km north of Malatya in the Republic of Turkey. Minerals characterization with bench-scale concentrating and beneficiation tests were conducted to determine the necessary processing conditions and parameters to recommend a mineral processing flowsheet to produce desired quality. A pilot plant flowsheet was operated at the Coleraine facility to produce approximately 1.5 tons of magnetic concentrate, consisting of 68.7% total iron and 2.1% silica, for subsequent pelletizing tests. Pot grate furnace simulations were performed for a grate-kiln-cooler pellet induration system. The system was designed for three million metric tons per year (3.0 MTPY) operating with 91% yearly availability. Pelletizing test work, along with MEDUSA computer modeling, were used to generate a complete heat and mass balance for the proposed induration; to validate the basis of design for plant productivity and to provide a conceptual process flow diagram. The final design was used to produce fired pellets, physical and metallurgical quality evaluation, and to supply ERMADEN with sufficient quantities of pellets for blast furnace customers‘ evaluation.

Minnesota Taconite Operations
Process airflow surveys have been conducted at three (3) of the six (6) taconite operations in Minnesota. The objective of these surveys is to measure process airflow, evaluate ingress and egress leakage for the current operating conditions, and to identify any possibilities for process improvement. Airflows will be measured on all incoming and outgoing process ducts on the systems. Data collected during these surveys are used to create a mass and energy balance around the furnaces.

Minerals, Non-Ferrous
History of Gold Exploration in Minnesota
Analysis of the work conducted in the Mud Creek area of the Vermilion District indicates that there are multitudinous gold showings (>1 ppm Au) in rock outcrops, and anomalous gold grain counts in the glacial till in close proximity to the Vermilion Fault. Overall, gold values show an increase toward the fault. Exploratory drilling along fault splays and shear zones to the south of the Vermilion Fault failed to find significant zones of sufficient thickness and gold grades to ever be considered as hosting a potential ore deposit. However, the actual trace of the Vermilion Fault was never drilled and should be tested in the future – especially the potentially more brittle, deformed granitic rocks to the north of the fault. Analysis of the work conducted in the Shagawa Lake prospect, and nearby Quartz Hill prospect, of the Vermilion District also show impressive gold values in both outcrop and drill holes. However, all of the data indicate that the mineralizing system has since been rotated to a sub-horizontal trend, which appears not to have been considered during the early stages of exploration.

Peat, Industrial Products
Horticultural Peat [i]External Sales Agreements
In addition to sponsored projects listed under the Peat Resources & Applied Wetland Rehabilitation Research Group‘s activities, this Group is also involved in assisting a number of horticultural peat

companies with regulatory permitting and environmental review for expansions and new operations. NRRI personnel act as a facilitator between peat companies and governmental regulators to find common ground and resolve permitting issues in an environmentally sound manner. Horticultural peat companies that NRRI has worked with recently include: 1) Hawkes, Co. Inc., (Newfolden, MN); 2) Peat, Inc., (Cromwell, MN); 3) Berger Horticultural Products, Ltd., (Big Falls, MN); and 4) Premier Horticulture, Inc., (Cromwell, MN). External sales agreements with these and other peat companies have been ongoing for years, and allow the company managers ready access to NRRI permitting expertise.

Peat-Based Media For Waste Water Treatment

Igor Kolomitsyn is leading the industrial team with American Peat Technology, LLC, to develop peat-based media for wastewater remediation. The team was able to scale up a laboratory procedure for production of newly modified peat granules. Recent (May 2011) industrial trials were successful in manufacturing a newly-developed peat granule on an industrial scale.

CENTER FOR WATER AND THE ENVIRONMENT

Water Resources

Center for Water and the Environment scientists have completed two Surface Water Assessment (SWA) grants from the Minnesota Pollution Control Agency (MPCA) during the period 2008-2011 to assist the agency as they conduct a systematic assessment of streams, rivers, and lakes throughout Minnesota. Their goal is to apply a standard sampling framework to assess the condition of water resources in the state on a ten-year rotation. The first project, SWA-Northshore, focused on: 1) intensive sampling of 17 Lake Superior trout streams for water quality, macroinvertebrates (bugs), and habitat; 2) helping establish long-term volunteer stream monitors; 3) compiling historical Natural Resources Research Institute, University of Minnesota Duluth, and Environmental Protection Agency stream data for MPCA‘s assessment process; and 4) to help develop computer models linking these data to land use in their watersheds. The SWA-St. Louis River watershed project continued, and broadened this collaboration to include sampling of 34 of MPCA‘s 118 sites within the watershed for intensive water quality in 2009 and 2010, and habitat, bugs, and fish in 2009. NRRI is also combining these data with its stressor gradient approach to identifying environmental risks based on techniques originally developed in the Great Lakes Environmental Indicator project and subsequent projects. Analyses are in progress that will test the utility of an alternative site selection technique to MPCA‘s using an anthropogenic stress gradient developed for the St. Louis River watershed to: 1) ensure representation of sample sites across the entire gradient, 2) identify potential ‗least impacted (reference) areas‘ within the watershed, and 3) identify probable causes of impairment identified via water quality or biological data. A third part of the project is to develop techniques to ‗cross-walk‘ macroinvertebrate sampling and processing techniques used by MPCA and NRRI to allow more efficient use of historical and modern NRRI and EPA data sets collected using a variety of sampling techniques that MPCA has not used due to their higher cost. Together, these SWA funded projects are extremely valuable in understanding the condition of Minnesota‘s Superior basin streams (including those flowing into the St. Louis River estuary), in understanding the effects of natural watershed characteristics, and land use management practices on their water quality and biological communities, and for developing the tools needed by local managers and decision makers to conserve the resources over the long-term. The analyses are continuing via two graduate student M.S. theses and are being incorporated into other NRRI collaborative research projects focused on the St. Louis River estuary and Area of Concern, Minnesota‘s North Shore of Lake Superior, and the Lake Superior coastal zone. Results to date indicate that although macroinvertebrate sampling methods do indeed result in different metric values, the differences in many of the summary values are systematic, thereby allowing development of a regression relationship to predict one value from the other.

Moose Research in Northeastern Minnesota

Moose are one of the iconic species that people associate with northeastern Minnesota. The moose population has been declining over the past six years, with a count of about 8,000 in 2005, and a count of < 5,000 in 2011. The linear decline will probably not continue until 2022, but the rate of decline is a cause for concern.

NRRI scientists have begun a large research project to help identify the causes of this decline, and to provide managers with guidelines for habitat management. The project includes four separate projects done in cooperation with biologists and managers at Voyageurs National Park, the Grand Portage Indian Reservation, the Minnesota Department of Natural Resources, and Quetico Provincial Park in Ontario. There are many other cooperating agencies and tribal organizations because a project this big could not otherwise be accomplished.

In January 2011 we placed GPS collars on 64 moose in northeastern Minnesota. These collars record locations every 20 minutes. Locations are sent daily via satellite and retrieved at NRRI. The collars should last two years, making this one of the largest, if not the largest moose study ever in the world. By the end of this project we should have about 1.5 million locations.

These locations will tell us how moose are using the different cover types, where they go to feed, what types of habitats are used as thermal refugia when it is hot, and how much access to water is needed. In addition, we will be able to learn other ways that moose respond to warm temperatures, for example shifting activity to night-time when it is cooler.

We will also learn other important things about moose biology. When moose calve they stay within a relatively small area (300 x 300 yards) for about two to three weeks. To date no one has been able to document post-calving movements of cows and calves at this fine resolution. We will use these locations to determine if the first two to three weeks are the major cause of high calf mortality.

Finally, we will be better able to identify cause of death because we obtain locations daily. If a collar is still for a day or two, then we will move in to the site, obtain samples, and try to figure out why the moose died. Collectively, with all of the cooperators on the study, these research techniques will help us give the moose population the best chance for continued persistence in Minnesota.

Center for Research and Applied Technology Development

Forest Products

Developing Thermal Verification Guidelines for Firewood

Objective

The objective of this project is to improve the current temperature monitoring process for heat treating firewood by developing the necessary background data that can be used to develop thermal verification guidelines that are primarily based on the kiln heating conditions to supplement the data from the firewood samples.

Background

Heat sterilization is currently the most practical and official treatment to kill Emerald Ash Borer (EAB) in infested ash firewood. To stop further spread of EAB, the USDA Animal and Plant Health Inspection Service (APHIS) has enforced a heat treatment process for the U.S. firewood industry to heat sterilize all hardwood firewood before it can be shipped out of infested areas. Yet, many firewood producers have had challenges implementing the heat treatment process in firewood operations due to a lack of sufficient heating facilities and a reliable temperature monitoring system. Significant operator errors were also found to occur in the current monitoring process. The purpose of this project is to improve the current heat treatment process by developing generic thermal verification guidelines that are primarily based on kiln conditions, eliminating most operator errors that exist in current heat treatment practices. This project will be conducted by a multidisciplinary team that include university and federal laboratory researchers, state wood products specialists, USDA APHIS Plant Protection and Quarantine officers, and field regulatory staff from several states.

Previous Activity

This is a new project.

Current Activity

We have identified several potential Minnesota cooperators to help our project team acquire the needed data on temperature profiles of firewood and the control temperatures and humidity of the kilns used for drying firewood. Price Firewood of Cloquet, Minnesota has purchased and is installing a new kiln that will be used in this project. A previous cooperator, Green Thumb, has also agreed to allow the project team to acquire data.

The NRRI staff has developed a relationship with the Minnesota Department of Agriculture, who is responsible for permitting and auditing heat treating facilities for firewood in Minnesota. We participated in a training for the inspection staff, sharing lessons learned from our previous projects on heat treating of firewood. USDA APHIS has also provided key information and training materials. A project extension was requested and approved by the sponsor until June 30, 2012.

Principal Investigator(s)

Brian Brashaw
Timothy Hagen

Project Sponsor(s)		Amount	Account	Active	
USDA Forest Service		43,996	3002-10414-00016003	07/01/2010	06/30/2012
	Total	$43,996			

Start Date: 07/01/2010 **End Date:** 06/30/2012 **Project ID:** 1601

Forest Products

Development of a Solar Decathlon

Objective

Work with multiple departments at UMD to formulate a proposal for the 2013 competition.

Background

The Solar Decathlon is a student driven collegiate engineering design competition sponsored by the US Department of Energy's National Renewable Energy Laboratory. This event is held every two years where teams from around the world build a positive energy house that is temporary, and commissioned in the Washington DC metro area. This is a juried competition consisting of ten technical and industrial development focus areas. The vision is to bring a wide array of colleges and departments within the colleges at UMD together to write a proposal for the 2013 competition.

Previous Activity

A steering committee has been formed with department representatives from civil engineering, mechanical engineering, graphic arts, marketing, facilities, and the Natural Resources Research Institute (NRRI).

NRRI hired two marketing students to begin developing market research that will help drive the message across campus and into the business community. The business community support is essential for a successful proposal – without strong industrial development support with in-kind and cash donations the project will not be feasible.

Current Activity

The proposal was stalled when negative comments by President Bruinicks regarding past performance of programs such as the Solar Decathlon and Solar Car were made in testimony to State Legislators.

The group decided to table the conversation until the fall when the request for proposal became available for review. One idea that surfaces was the potential to collaborate with Mankato State University in a joint proposal.

Principal Investigator(s)

Patrick Donahue

Project Sponsor(s)	**Amount**	**Account**	**Active**	
	35,000	1000-10414-20090-100000	09/23/2010	06/30/2012
Total	$35,000			

Start Date: 09/15/2010 **End Date:** 07/01/2011 **Project ID:** 1602

Forest Products

Development of Torrefied Wood Microchips as an Energy-Efficient Biofuel for Pellet Stoves and Boilers

Objective

To develop a torrefied microchip capable of providing a viable replacement for traditional wood pellets as a biofuel in pellet burning stoves and boilers, resulting in reduced energy and environmental impacts of the wood-based pellet industry.

Background

Effective use of biomass requires pretreatments to allow material to be used without significant modification of existing combustion systems. Ideally, the pretreated biomass should garner properties that allow the materials to be routinely deployed in a manner similar to fuels currently used. This facilitates better overall cost effectiveness and capital cost optimization when using a percentage of biomass in the fuel mix applications. One such pretreatment technology is torrefaction. Torrefaction is a thermal process in which biomass is heated in an oxygen deprived atmosphere at temperatures of 270°C to 300°C. Torrefaction requires a biomass combustor in combination with a dryer placed upstream of a reactor capable of heating to 300°C in an oxygen deprived atmosphere. The combustor provides heat for the process by combusting a fraction of the solids exiting the dryer, while remaining solids from the dryer enter the torrefaction reactor. In this roasting environment, volatiles are driven off, thereby changing the nature and properties of the product. The atomic H/C and O/C ratios are driven downward to some desirable endpoint.

Previous Activity

Torrefaction is a viable candidate for retro fit or possible addition of a conventional biomass pelleting plant. NRRI focused on gaining a better understanding of the nature and properties of torrefied wood micro-chips as a utility fuel and as a pre-treatment step for pelleting and briquetting applications. Ten tree species widely available throughout the Upper Midwest were selected and torrefied to a specific target of 30% dry solids loss at 300°C using small 350 cm3 aluminum torrefaction reactors. Our approach was to quantify Hardgrove grindability, grinding energy, heating value, pellet ability, pellet strength, and pellet durability and to assign grindability criteria for each of the ten tree species. In addition, selectively processing well-characterized micro-chips of red pine, tamarack, soft maple and birch through a 75,000 cm3 rotary reactor has been planned, allowing us to produce quantities for actual combustion trials in various pellet heating appliances.

Current Activity

All ten tree species respond favorably to torrefaction. In general, 70% of the mass is conserved, while retaining 90% of the wood energy content. Dry Solids Loss (DSL) through torrefaction was found to be a significant indicator of how easily the materials respond to grinding. Uniformity of particle size was found to be a critical parameter for successful torrefaction. Pilot quantities of tamarack, red pine, soft maple and birch were processed through an Acrowood and Rotochopper brand wood chipper. One yard of well-defined wood chips was obtained for further drying and torrefaction trials.

Principal Investigator(s)

Timothy Hagen

Project Sponsor(s)	Amount	Account	Active	
MN Initiative for Renew Energy&Env(IREE)	66,042	1780-10414-21314-100000	07/01/2010	08/30/2011
Total	$66,042			

Start Date: 07/01/2010 **End Date:** 08/30/2011 **Project ID:** 1594

Forest Products

Development of Torrefied Wood Microchips as an Energy-Efficient Biofuel for Pellet Stoves and Boilers

Objective

To develop the torrefaction, densification, and grinding specifications for wood microchips produced from a variety of tree species.

Background

The use of torrefied microchips in pellet stoves may require pretreatments to allow the material to be used without significant modification of existing burner or feed systems. Ideally, the microchips should garner properties that allow them to be routinely deployed in a manner similar to pellet fuels. NRRI has been investigating torrefaction as means to improve biomass properties. Torrefaction is a thermal process in which biomass is heated in an oxygen deprived atmosphere at temperatures of 270°C to 300°C. The benefits are: increased heating value, lower equilibrium moisture, sheds moisture, grinds and densifies easily, emits little smoke when burned, and is inert upon stowage.

Previous Activity

Ten tree species widely available throughout the Upper Midwest were selected and torrefied to a target specification of 30 % dry solids loss at 300°C using small 350 cm3 aluminum reactors. We quantified Hardgrove grind ability, grinding energy, heating value, pellet ability, strength, and durability, equilibrium moisture and assigned a grind ability criterion for each of the ten tree species.

Current Activity

The rate of weight loss as a function of time for the 10 tree species was quantified and had bi-modal peaks appearing at 20-30 and 40-50 minutes retention time. This shows volatiles driven off from the wood occur in different time periods and release at different rates. In general, hardwoods had sharper parabolic bi-modal curves while softwoods had flattened bi-modal curves. Pellet durability was found to be 95% or greater, pellet density was 60-70 pcf and fracture strength ranged from 1500-2500 psi. Grinding energy differs across species and ranges from a low of 100 kwh/ton for red oak to 185 kwh/ton for aspen. Aspen was the most difficult to grind as evidenced by a grindability criterion of 18,000 kwh/ton/ton. DSL was a significant indicator of hardgrove grindability for both pellets and microchips. Hardgrove grind ability at a torrefaction specification of 30% DSL at 300°C was found to be 30 for pellets and 60 for microchips. This is near the norm for most coal types. Heating values of >10,000 btu/lb and 5% EMC at 70% RH were routinely obtained. Combustion trials of microchips were found to be acceptably positioned, with the provision that feed rate to the appliance needs to be increased at high burn rates. Flow ability of the microchips were comparable to pellets.

Principal Investigator(s)

Timothy Hagen

Project Sponsor(s)	Amount	Account	Active	
MN Initiative for Renew Energy&Env(IREE)	66,042	1780-10414-21314-100000	07/01/2010	08/30/2011
Total	$66,042			

Start Date: 07/01/2010 **End Date:** 06/30/2011 **Project ID:** 1652

Evaluation and Demonstration of Nondestructive Assessment Technologies for Sorting Eastern Hardwoods

Objective

To evaluate several technologies including vibration, acoustic, tomography, thermography, and laser technologies for identifying critical material defects and for assessing potential product performance from hardwood materials prior to manufacturing into guitars and baseball bats, to assess the potential for these technologies to be used for other high value end products, and to identify commercial vendors that are capable of adapting equipment or developing new equipment.

Background

Recent advances in nondestructive assessment technologies offer opportunities to evaluate hardwood raw materials, particularly the potential quality of material that is used in the manufacture of high value specialty products. This proposed effort will focus on evaluation of several technologies for assessing the quality of material to be used in high value specialty products, with an emphasis on raw materials for use in manufacturing guitars and baseball bats. The outputs from this project would include an evaluation of these technologies and equipments, demonstration on these products, and the suitability for use in other high-value products.

Previous Activity

A tour of both C.F. Martin Guitar (Nazareth, Pennsylvania) and Rawlings Adirondack (Dolgeville, New York) was completed to understand the types of defects and opportunities for including nondestructive evaluation technologies in their operations. The specific defects identified at C.F. Martin Guitar were identified as compression microcracking that occurred from wind breaks during forest growth or harvest. Samples were obtained for conducting in-depth trials using nondestructive evaluation technologies such as thermography or laser shearography. Preliminary testing was completed with thermography, showing some potential for identifying cracks.

Current Activity

There was minimal activity during this reporting period due to other priority project activities for NRRI. The project received an extension from the sponsor until 6/30/2012.

Principal Investigator(s)

Brian Brashaw

Project Sponsor(s)		Amount	Account	Active	
USDA Forest Service		50,000	3002-10414-00008448	07/01/2009	06/30/2012
	Total	$50,000			

Start Date: 07/01/2009 **End Date:** 06/30/2012 **Project ID:** 1552

Grand Log Homes

Objective

To fully develop the Grand Log technology by developing the production process, producing enough product to complete performance testing, constructing a demonstration site, and producing trade show booth and sales samples, which will lead to the start-up of a manufacturing plant in northern Minnesota by the end of 2011.

Background

Grand Log Homes™ has developed the Grand Log™, which combines the durability, authenticity, and curb appeal of solid logs with greater energy-efficiency, stability, and remodeling options, along with less weight and much lower life-cycle costs. The Grand Log™ hybrid log technology is the culmination of original NRRI research and maintenance field data from more than 160 North American installations of a veneered foam-core log siding.

Grand log Homes™ will compete in the 4+ billion dollar log home marketplace with more than 55 years of battle-tested product design, engineering, product commercialization, manufacturing, construction, and sales experience. This marketplace includes log home package sales, large diameter log siding sales, and log installation revenues. Grand Log Homes™ will focus on the log home, hospitality & upscale rustic construction industries, in addition to the architectural, governmental, and vacation homeowner segments of the marketplace.

Previous Activity

This is a new project.

Current Activity

Prototype samples of the original concept drawings for the Grand Log™ were created and used to develop parameters for manufacturing 12 ft lengths during regular production. A prototype assembly jig was conceptualized, developed, and tested using 4 ft lengths. Several improvements were noted and completed. Adhesive requirements, application method and placement during assembly were also evaluated. Adjustments were made by the inventors in the design of the product to improve assembly and reduce waste during production. An on-site visit to a potential component milling company was conducted in June 2011 to assess the potential for toll manufacturing during 2011.

Principal Investigator(s)

Brian Brashaw
Victor Krause

Project Sponsor(s)		Amount	Account	Active	
Blandin Foundation		25,769	3001-10412-00024205	01/01/2011	05/12/2012
	Total	$25,769			

Start Date: 01/03/2011 **End Date:** 05/12/2012 **Project ID:** 1651

Integrated Acoustic Assessment Technologies for Optimal Wood Products and Wood Biomass Utilization

Objective

The objectives are to: (1) Develop economic assessment models that incorporate wood quality, carbon and bioenergy values along with end markets for use with acoustic-based nondestructive assessment technologies; (2) Identify implementation strategies and guidelines for use with standing trees, stems, and logs for regional application across the varied forest cover types; and (3) Develop a nondestructive approach to accurately determine wood density for individual species within a localized forest stand.

Background

The University of Minnesota Duluth has been at the forefront in the development of robust nondestructive evaluation (NDE) technologies capable of predicting the wood properties of trees, stems, and logs, and assessing the value of stands and forests. In this project, the University of Minnesota Duluth will collaborate with the College of Menominee Nation and the USDA Forest Products Laboratory to evaluate previous data sets and conduct an assessment of standing timber in Wisconsin to provide advancements and refinements of acoustic assessment technology to ensure that these methods will be successfully implemented for managing wood quality, assessing the forest value, and ensuring efficient use of woody biomass.

Previous Activity

A project team meeting was held at the College of Menominee in Keshena, Wisconsin. A technical review of acoustic technologies and a hands-on demonstration of the log tool (Hitman 200), standing tree tool (STS 300), and resistance microdrill was provided. This provided needed context to the use of these tools to assess standing trees and logs during the project. A tour of the MTE forest lands and sawmill was completed to review logging technology and sawmill equipment.

Current Activity

The Forest Products Laboratory and NRRI prepared and submitted a draft report that included a literature review on the use of nondestructive inspection as a means to predict quality of logs and lumber. It also included a section identifying and summarizing the use of various nondestructive evaluation techniques for predicting density and specific gravity. This information was used to design and conduct testing of tree discs to determine the relationships between stress wave velocities and resistance microdrilling measures with density. Fifty sugar maple discs and 35 hemlock discs were measured and the data is being analyzed. A trial was completed at Menominee Tribal Enterprises to assess the variability in longitudinal velocity of various common species like sugar maple, white pine, red oak, basswood, and hemlock. This data showed that enough variability resulted to allow for selection of standing trees for the next phase of the project.

Principal Investigator(s)

Brian Brashaw

Project Sponsor(s)	Amount	Account	Active	
College of Menominee Nation/(USDA)	69,858	3014-10414-00016414	10/01/2010	09/30/2012
Total	$69,858			

Start Date: 10/01/2010 **End Date:** 09/30/2012 **Project ID:** 1610

Phosphate Bonded Fiber and Waste Residual Composites for Applied Commercialization, Research into

Objective

To develop durable building materials from paper mill waste using novel phosphate ceramic binders.

Background

This project has been funded by the Wisconsin Business Innovation Corporation with resources they received from the U.S. Environmental Protection Agency. There is over 3,000 tons of primary paper mill waste in Wisconsin daily. This waste consists of 50 percent fiber and 50 percent clay. The goal is to use novel mineral based binder technology to create a series of durable building materials using this waste stream as the primary manufacturing feedstock.

Previous Activity

The outcome of the corrosion testing was positive. UMD's Department of Civil Engineering, led by Dr. Eric Musselman, completed the corrosion testing. We tested brass, zinc, bronze ceramic-coated, stainless, and hot-dipped galvanized fasteners. As control samples, we tested the corrosion properties of the same fasteners in competitive on-the-market fire-rated door core products. Dr. Musselman shared the results with his colleague, they both agreed that if corrosion were going to occur it would have already been initiated during the test period.

The corrosion testing results were shared with Marshfield Door Systems and they were pleased. They inquired with a local paper mill and determined that it would be economically feasible to transport the waste residue from the paper mill to their manufacturing plant. We shared our product components with them (we have an active Confidentiality Agreement in place), they are currently conducting an economic analysis to determine if our preliminary product costs could be competitive with the products they currently use. We are awaiting the outcome of this economic analysis. Our goal is to execute a research agreement with Marshfield Door Systems. If they decide not to pursue further development, we will contact other interested companies. We developed a color brochure to market our technology - this will be used for all

Current Activity

Marshfield Door System's analysis of our technology showed that it would be cost-effective to manufacture. They have most of the current infrastructure/equipment in place. However, due to a plant accident, they informed us that they cannot pursue our technology at this time. We hope to reopen possible negotiations soon.

Matt Aro was invited to give a presentation at the Window and Door Manufacturers Assoc. 13th Technical Conference in Grand Rapids, Michigan, June 20-22, 2011. His presentation garnered much interest from door manufacturers and he was approached by several manufacturers for more information.

Algoma Hardwoods showed strong interest. Matt Aro and Pat Donahue, along with our partners at the Wisconsin Business Innovation Corporation, agreed to visit Algoma's plant for a tour and to discuss possible licensing opportunities. These discussions are ongoing.

The final technical report was submitted to the sponsor. We continue to pursue technology licensing opportunities with industry.

Principal Investigator(s)

Matthew Aro

Patrick Donahue

Project Sponsor(s)	Amount	Account	Active	
Wisconsin Bus Innov Corp-Prime EPA	136,407	1653-187-6609-00	11/01/2007	09/30/2010
Total	$136,407			

Start Date: 11/01/2007 **End Date:** 06/30/2011 **Project ID:** 1501

Forest Products

Thermally Modified Wood and Plywood

Objective

To develop niche applications of thermally modified wood and plywood for the transportation trailer industry and for the engineered wood flooring industry.

Background

Thermally modified wood technology has been steadily gaining acceptance in Europe. The industrial processing has begun to find its way into North American applications. This project is a focused effort to develop niche applications for these methods to increase the sales for two Minnesota businesses.

The project will develop two niche applications; one for the transportation trailer industry and the other for the engineered wood flooring industry.

The project has two Minnesota based businesses as its core partners. These businesses will assist in the product and process development creating new products that in both cases displace important wood products with domestic sourced materials using thermally modified wood technologies.

Previous Activity

This is a new project.

Current Activity

Principal Investigator(s)

Patrick Donahue

Project Sponsor(s)	Amount	Account	Active	
NRRI Product Development Fund	20,087	3001-10412-00024913	02/01/2011	07/31/2011
Total	$20,087			

Start Date: 03/01/2011 **End Date:** 12/31/2011 **Project ID:** 1653

Forest Products

Thermally-Modified Eastern Hardwoods as High-Tech Fenestration and Exterior Shuttering

Objective

To assess thermally modified wood as a feed stock for the regional wood window and door industry.

Background

The project goal is to analyze ThermoWood® modified basswood and yellow poplar hardwood lumber with advanced screening methods developed by the Window and Door Manufacturers Association to provide a direct comparison of their performance properties with those of traditional softwood lumber used by the fenestration and exterior shuttering industry. The outcome will provide an opportunity for these advanced materials to be thoroughly vetted by manufacturers, engineers, and designers in the fenestration and exterior shuttering industries with a detailed technical baseline for new Eastern hardwood applications.

Previous Activity

Work continued on the primary project objective: performance testing based on Window and Door Manufacturers Association (WDMA) Industrial Standard IS-10. WDMA IS-10 consists of 21 ASTM/WDMA performance testing protocols to understand the properties of modified and composite cellulosic fiber.

NRRI contracted with Michigan Technical University Wood Science Department to complete the biological decay testing as a final step in completing the project. Business development interest continues to be strong.

Current Activity

The project was completed. A final report is being submitted to the sponsor. The results demonstrated that thermally modification processes significantly improved the dimensional stability and decay resistance of the hardwoods species studied, creating an industrial feed stock that would be suitable for application in domestic fenestration products.

In the case of yellow poplar, the dimensional stability improved on average of 70% over untreated controls. In the case of basswood, the dimensional stability increased 50% on average over untreated controls. This improved property is largely based on the change in the physical properties of the wood to absorb far less atmospheric moisture compared to untreated controls.

This change in physical property also produced a significant improvement on decay resistance. In the case of yellow poplar the weight loss of fiber by decay was reduced by 23%. In the case of basswood the weight loss of fiber was reduced by 41%.

The mechanical properties were all reduced by the thermal modification process. In the case of yellow poplar, even though the reduction was as much as 40%, the final properties remained above Ponderosa pine which is the primary wood feedstock in the North American fenestration industry. The mechanical property of greatest concern is the reduction in split resistance.

The project has provided a solid starting position to further develop this technology for regional fenestration.

Principal Investigator(s)

Patrick Donahue

Project Sponsor(s)		Amount	Account	Active	
USDA Forest Service		47,514	3002-10414-00008459	07/01/2009	06/30/2011
	Total	$47,514			

Start Date: 07/01/2009 **End Date:** 06/30/2011 **Project ID:** 1550

Forest Products

Top That! By Loni

Objective

The goal of this project is to provide training and hands-on production process improvements that allow Top That! to increase their production efficiency and reduce manufacturing waste, resulting in increased capacity and ability to service additional customers in 2011.

Background

Top That! By Loni is a small custom sewing company based in International Falls, Minnesota that specializes in the production of custom boat canvases and alteration and repair services for both business and consumers in International Falls and the surrounding area. Top That! was a Labovitz Award Winner in 2008 in the Micro-Entrepreneur category.

Previous Activity

This is a new project. No previous activity to report.

Current Activity

Training on lean manufacturing including identification of production waste, 5S, cellular manufacturing, total productive maintenance, and quality production principles was completed. This training included development of a current and future value stream map for Top That!, and determination of shop floor improvements that would help to reduce waste and maximize value-added production. Along with Top That! staff, shop floor improvements were implemented during a blitz project on-site. This included the construction of a new sewing table, the expansion and relocation of another sewing table. New storage was created for necessary tools and materials. Work benches were reduced in size to allow for more efficient work processes and ease in location of tools. An on-site project was scheduled for July 2011 to help with additional production improvements.

Principal Investigator(s)

Brian Brashaw
Victor Krause

Project Sponsor(s)		Amount	Account	Active	
Blandin Foundation		13,690	3001-10412-00023731	05/15/2010	05/12/2012
	Total	$13,690			

Start Date: 01/03/2011 **End Date:** 05/12/2012 **Project ID:** 1650

Total Productive Maintenance for the Wood Products Industry

Objective

Develop customized total productive maintenance programs for wood products manufacturers through development of short courses and in-plant demonstration projects. A secondary objective is to use web-based video conferencing to conduct total productive maintenance training for regional groups of manufacturers as a means of reducing travel costs for employees and instructors.

Background

The project cooperators at Virginia Tech, Iowa State University, and the University of Minnesota Duluth have worked to help wood products manufacturers understand and implement lean manufacturing as a preferred continuous improvement program to support their economic stability and growth. Through these efforts, these cooperators have identified the need for wood products companies to strengthen their equipment reliability, minimize downtime, and improve productivity. Total productive maintenance programs are widely accepted as a key strategy by world class manufacturers as a means to satisfy these needs.

Previous Activity

A summary of the project outcome is shown in the Current Activity Section of this report.

Current Activity

The final report was submitted to the project sponsor with the following accomplishments.
(1) UMD and Virginia Tech wood products teams have added total productive maintenance (TPM) capacity to their lean toolboxes. (2) A hands-on TPM training and simulation was developed with a specific emphasis to the wood products industry. This training, incorporating gas-powered air compressors, was effectively provided to over 25 companies and organizations during this project. It contained the following sections: TPM overview and philosophy, basic equipment care, clean to inspect approach, countermeasures and visual aids, planned maintenance and development of cleaning and lubrication standards, predictive tools, and summary and implementation. (3) An interactive video conferencing short course was held in 2010. Virginia Tech and University of Minnesota Duluth instructors joined together to conduct an interactive video conferencing workshop on Total Productive Maintenance. In Virginia, instructors Earl Kline and Brian Bond facilitated a group of 11 industry participants and students. Over 1200 miles away, NRRI instructors Brian Brashaw and Bob Vatalaro facilitated a concurrent workshop to a group of nine industry participants. (4) Seven team-based TPM projects were completed with wood products manufacturing companies in Minnesota, Wisconsin, and Virginia. (5) Dry ice cleaning technology was identified and demonstrated as a very effective and green technology for deep cleaning equipment during TPM events. (6) Several trade publication articles were prepared and published, providing additional opportunities for technology transfer.

Principal Investigator(s)

Brian Brashaw

Project Sponsor(s)		Amount	Account	Active	
USDA Forest Service		95,479	1637-187-6601-00	07/01/2007	12/31/2010
	Total	$95,479			

Start Date: 07/01/2007 **End Date:** 06/30/2011 **Project ID:** 1467

Use of Laser Scanning Technology to Obtain As-Built Records of Historic Covered Bridges

Objective

To examine the technical feasibility of using laser scanning technologies for obtaining as-built records for historic covered timber bridges.

Background

Covered bridges have been the fabric of American life. Today there are several hundred historic covered bridges remaining. Although there is much effort to preserve these structures, often times high cost of restoration, neglect, and vandalism takes its toll, and many are lost forever. One of the more famous bridges from the movie "Bridges of Madison County" was burned down last year. The National Park Service's Historic American Engineering Record (HAER) has efforts underway to document historic structures and consists of measured and interpretive drawings, large-format photographs, and written historical reports. In order to assist in this effort, new technologies need to be explored which can provide as-built records at a faster rate with more accuracy. This research will explore the use of laser scanning technology to scan existing bridges for purposes of obtaining as-built records.

Previous Activity

Faro, Inc., a laser equipment manufacturer, and Kubit USA, a software company, were identified and secured as primary project cooperators. A Faro, Inc. scanner demonstration was held in July 2009 as a historic steel bridge was scanned on the grounds of Minnesota's St. Louis County Richard H. Hansen Public Works and Transportation Complex. Our scanning contractor, SightLine, LLC, conducted scanning of The Red Bridge in Cedarburg, Wisconsin, the Zumbrota Bridge in Zumbrota, Minnesota and four of the famous Madison County, Iowa bridges. The data was processed creating a Point Cloud of the bridge and its surroundings. This data was further developed into 3D and 2D computer aided design images that contained accurate dimensions of the bridge.

Current Activity

The project team continued to develop background and understanding of the use of 3D laser scanning for documenting historic structures. Specifically, we developed new capacity to process the scan data to both develop as-built documentation of the existing condition of bridges showing areas of deformation, rotation, or twist. A second option exists to process the Point Cloud data to correct the deformations, allowing for the creation of new blueprints that would be necessary should a bridge need to be rebuilt.

As part of the Zumbrota, Minnesota scans, a 1/100th scale replica of the bridge was created in the NRRI Northern Lights Prototyping Center. A final report was submitted to the City Engineer in Zumbrota, along with several blueprints of the bridge for their files.

NRRI staff participated with UMD faculty to prepare a successful funding proposal to the University of Minnesota Infrastructure Investment Initiative. Funds will be used to purchase a FARO scanner that will be used in a future bridge scanning project and in other potential applications requiring detailed 3D images.

Principal Investigator(s)

Brian Brashaw

Project Sponsor(s)		Amount	Account	Active	
USDA Forest Products Lab		65,000	3002-10414-00012627	07/28/2009	01/31/2012
	Total	$65,000			

Start Date: 07/28/2009 **End Date:** 06/30/2011 **Project ID:** 1570

Wood Utilization Options for Urban Trees Infested by Invasive Species

Objective

To develop web-based information archives and user-friendly guidelines for assessing wood utilization options for woody materials obtained from trees infested by various invasive species.

Background

Invasive species have been identified as one of the four significant threats to our Nation's forest and rangeland ecosystems, characterized as a "catastrophic wildfire in slow motion." Emerald ash borer (EAB), for example, was discovered in southeastern Michigan in 2002 and has spread to many other states in the northeastern region of the U.S. including Illinois, Wisconsin, and most recently Minnesota. As a result of infestation from invasive species, particularly EAB, tremendous numbers of infested trees are being removed each year for control and ultimate eradication of the pests. Proper utilization and safe disposal of woody biomass from these trees constitute challenges to many local communities and land owners. Urban forestry professionals are faced with the task of selecting appropriate utilization options for the materials and locating necessary technical information for making such decisions. As invasive species control efforts increase, a comprehensive wood utilization guideline is needed by urban communities and forestry professionals to quickly assess utilization options for wood obtained from infested trees.

Previous Activity

The book on wood utilization options was completed in draft form. The initial chapter focused on the material properties of ash and other affected species. NRRI staff participated in listening sessions that were conducted in cooperation with the Minnesota DNR. These listening sessions confirmed the direction of this project as it identified the greatest challenge for ash utilization in Minnesota. The greatest challenge is the lack of information and education on ash markets including access to existing markets (currently limited) and developing markets, utilization options, and wood properties. This information will be used to guide the completion of the project.

Current Activity

Work was completed on several chapters of this book including the chapters on mechanical properties of ash and other hardwoods, anatomy of ash species, considerations for thermal treating of ash firewood, and an introductory chapter on the status of EAB infestation in the U.S. These chapters have been prepared by our editor for publishing. The final chapter of the book to be prepared is a summary of all utilization options for ash lumber, logs, and chips. An extension to the project was received for a new end date of December 31, 2011.

Principal Investigator(s)

Brian Brashaw

Project Sponsor(s)		Amount	Account	Active	
USDA Forest Service		46,845	3002-10414-00008444	07/01/2009	12/31/2011
	Total	$46,845			

Start Date: 07/01/2009 **End Date:** 06/30/2011 **Project ID:** 1573

Wood Utilization Research 2009

Objective

To help the forest products sector develop new products, new technologies, and new business systems to position Minnesota as a continued leader in wood products manufacturing and renewable energy.

Background

The overall objective of the project is to complement a program of the University of Minnesota Duluth Natural Resources Research Institute. Major goals include: (1) helping existing small and mid-size wood products companies remain or become competitive through research and development; (2) conducting forest productivity work in hybrid poplar, red pine, and other Minnesota species to ensure the sustainability of the forest products industry and to help Minnesota meet their 2025 renewable energy mandate; and (3) formation of new regional industries based on forest products materials and technologies. Specific subprojects include the following topics: (1) development of assessment models for woody biomass utilization; (2) fenestration development using thermally modified wood; and (3) development of new silicone/cellulose sealant/rubber materials.

Previous Activity

A literature review has been conducted on equipment options for assessing value of woody biomass through wood quality assessments. In the thermal modified wood subproject, our staff is collaborating with LakeHead University in planning to develop strategies for creating a North American thermally modified wood standard. They have also successfully produced thermal modified strand composite panels and plywood panels that appear to have potential for door and window applications.

Current Activity

Funds from this project were used to leverage project activities reported under project number 1610. This included the completion of a trial to determine the stress wave properties and variability among logs at the Menominee Tribal Enterprise sawmill facility. This information will help the project team select standing trees for the next phase in the project. This was the only activity conducted under the project during the reporting period.

Principal Investigator(s)

Brian Brashaw

Project Sponsor(s)	Amount	Account	Active	
USDA Coop ST Res ED & Ext Srvc (CSREES)	147,372	3002-10414-00000-000115	09/01/2009	08/31/2011
Total	$147,372			

Start Date: 09/01/2009 **End Date:** 08/31/2011 **Project ID:** 1572

Assessment of Biomass Sources for Energy in Northern Minnesota for the Laurentian Energy Project

Objective

To assess resources and economic feasibility of procuring woody biomass from poplar plantations, brushlands, and forest harvest residues for energy for the Laurentian Energy Authority project.

Background

This project is funded through the US Department of Energy with the purpose to assess the feasibility of producing woody biomass for energy for delivery to the Laurentian Energy Authority facilities in Virginia and Hibbing, located in northern Minnesota. The project will evaluate the economic and practical feasibility of the various biomass options and conduct research on plantation forestry and harvesting of brushlands. The following tasks are part of this project: (1) assessment of best management practices for harvesting of brushlands and forest harvest residues, (2) development and analysis of best available technology for harvesting brushlands, (3) biomass availability and collection technology for forest harvest residues, (4) biomass availability from rights-of-way and, (5) evaluation of available soils and variation in productivity of hybrid poplar plantations.

Previous Activity

Additional sites for measurement of top and limb biomass in Red Pine stands were located and sampled. In addition to the five completed in the spring of 2010, we currently have 11 sites completed. Data on all biomass components including top to a variable diameter-limit, live limb, dead limb weight, and bole volume and specific gravity were collected on individual trees. Genetic tests of hybrid poplar have been measured containing 42 clones that have been selected or bred in Minnesota by the UMD-NRRI program.

Current Activity

Data were analyzed to determine biomass component weight and develop equations to estimate biomass components in young Red Pine stands. On average, we found that tree bole and tree top-and-limb biomass comprise approximately 65 and 35 percent of the total oven-dry biomass, respectively. The proportion of biomass in the top-and-limb component is much higher than most other species common to the Upper Midwest. When expressed as a proportion of the bole biomass only, the top-and-limb biomass (that component typically available for energy) averaged 58 percent of the bole biomass. This information is useful to refine estimates of biomass available for energy uses from Red Pine stands. We are in the process of collecting financial information on common agricultural crops (e.g. corn and wheat) to allow estimation of the financial returns to landowners compared to energy crops such as poplar. Based on our cash flow analyses of hybrid poplar, the primary driver in determining the breakeven price of dedicated energy crops is land rent which is directly related to the financial return from the most profitable alternate land use. Cash flow analyses were recently updated with the assistance of our industrial cooperators to ensure that management costs for hybrid poplar acreage are consistent with actual experience based on a large poplar plantation program.

Principal Investigator(s)

William Berguson

Project Sponsor(s)	Amount	Account	Active	
Laurentian Energy Authority, LLC	150,000	3002-10414-00013380	06/01/2009	05/31/2011
Laurentian Energy Authority LLC (USDOE)	652,439	1906-187-6616-00	01/01/2007	05/31/2011
Total	$802,439			

Start Date: 01/01/2007 **End Date:** 05/31/2011 **Project ID:** 1513

Indirect Liquefaction of Wood Waste for Remote Power Generation Fuel

Objective

To evaluate the potential to produce methanol through thermochemical processes using wood resources native to Minnesota.

Background

The purpose of this project is to assist the University of North Dakota, Energy and Environmental Research Center (EERC) in the development and on-site testing of a portable gasification-to-methanol process unit. The participation of the UM-NRRI includes two tasks: (1) assistance in the location of an adequate site for testing of the mobile fuel production system, and (2) assessment of wood resources for conversion to liquid fuels in Minnesota. The UM-NRRI will assist the EERC in locating a test site that meets the requirements of the project. Also, we will assist the EERC in identifying and locating sources of wood species that may be particularly suitable for conversion to liquid fuels. We will recommend species-specific tests based on volume availability and price and assist in arranging for shipment of biomass materials to the test site as needed by EERC staff.

Previous Activity

Work has been done to develop databases to serve as a platform for analysis of current wood resource availability specific to species and type of material including roundwood and top- and limb-biomass. Also, assistance was provided to EERC in locating a site for testing of the truck-mounted gasification system. Due to delays in construction of the conversion system, the project has been extended to allow time for on-site testing on a site in Minnesota. We anticipate testing of the gasification system to begin in the spring 2011 with the gas-to-liquids module available for testing in the fall of 2011.

Current Activity

We continue to assess forest resource data to estimate prices and biomass amounts to guide the EERC in determination of species to be tested in the gasification-to-methanol conversion system. Initial testing of the conversion system is expected to begin this fall and we will assist the EERC in sourcing of biomass for these tests. We continue to update forest resource databases on species-specific biomass availability in anticipation of on-site testing.

Principal Investigator(s)

William Berguson

Project Sponsor(s)	Amount	Account	Active	
Univ of North Dakota (Prime: USDOE)	24,693	3014-10414-00011388	01/01/2009	09/30/2011
Total	$24,693			

Start Date: 01/01/2009 **End Date:** 06/30/2011 **Project ID:** 1574

Minnesota Forest Productivity Research Cooperative

Objective

To improve the productivity and value of natural stands and plantations in Minnesota, develop economically and environmentally sound silvicultural practices, and transfer this knowledge to Minnesota Forest Productivity Research Cooperative (MFPRC) members and the public.

Background

This MFPRC is a consortium of University of Minnesota personnel, industry members, and the USDA Forest Service with the purpose to enhance the productivity of Minnesota's forests. Research done as part of the MFPRC includes Norway Pine management, aspen productivity research, and hybrid poplar genetics and yield improvement. The goal of Norway Pine research proposed is to better understand productivity of Norway Pine plantations and optimize management of these stands both in terms of productivity and value. Aspen research is concentrating on assessment of productivity of regenerating aspen stands, an important issue as it relates to future wood resources. Hybrid poplar breeding and yield improvement is ongoing and replaces the previous activity done as part of the MFPRC.

Previous Activity

All growth data have been collected this fall from Red Pine thinning trials at eight sites. Work continued on establishment of new thinning experiments. At this time, the intended total of 13 study sites has been reached with thinning treatments either completed or scheduled for the 2011 season. Breeding of poplar to produce new progeny is currently underway with female parental stock being collected on sites near Alexandria, Minnesota. Analysis of poplar yield data and clone tests is ongoing with high yields of new P. deltoides clones approaching 4.5 to 5.0 ovendry tons of biomass per acre per year, a high rate of growth compared to previous studies.

Current Activity

Analysis of aspen production data were done to evaluate growth patterns at mid-rotation in well-stocked stands. This analysis involved development of a new set of volume-estimation equations to allow analysis of all components of biomass including main bole volume to a variety of minimum-diameter cutoffs. Analysis showed that the mean annual volume increment using a two-inch volume cutoff culminated between 25 and 30 years of age in most stands. This indicates that if markets were to develop for energy products, harvest rotations on some stands may be reduced to provide volume for these markets. Analysis of yield data of poplar plantations in central Minnesota was done during the reporting period. New clones that have been bred at NRRI in our breeding program have shown high yields comparable to and in some cases, exceeding those of current commercial hybrids. This indicates that the potential exists to diversify the genetic base of poplar plantations in the region while still maintaining and increasing production levels. Work on Red Pine thinning continues with identification of additional sites and layout of experimental plots on these new sites to enhance the network of existing Red Pine thinning sites.

Principal Investigator(s)

William Berguson

Project Sponsor(s)	Amount	Account	Active	
Blandin Paper Company	20,000	1664-187-6534-00	11/01/2004	06/30/2005
Boise White Paper LLC	20,000	1664-187-6535-00	07/09/2004	06/30/2005
International Paper Company	20,000	1664-187-6536-00	09/01/2004	06/30/2005
Minnesota Power	20,000	1664-187-6537-00	07/14/2004	06/30/2005
Potlatch Corporation	20,000	1664-187-6538-00	10/28/2004	06/30/2005
Forest Capital Partners LLC	20,000	1664-187-6558-00	07/01/2005	06/30/2006
Blandin Paper Company	20,000	1664-187-6563-00	07/01/2005	06/30/2006
Potlatch Corporation	20,000	1664-187-6562-00	07/01/2005	06/30/2006
Plum Creek	20,000	1664-187-6561-00	07/01/2005	06/30/2006
International Paper Company	20,000	1664-187-6559-00	07/01/2005	06/30/2006
MN Power	20,000	1664-187-6560-00	07/01/2005	06/30/2006
MN Power	20,000	1664-187-6594-00	07/01/2006	12/31/2006
MN Dep of Natural Resources(DNR)	40,000	1663-187-6542-00	11/30/2004	06/30/2007
MN Dept of Natural Resources (DNR)	400,000	1663-187-6581-00	07/01/2005	06/30/2007

St Louis County Land Department	20,000	1676-187-6585-00	11/15/2005	06/30/2007
Verso Paper	20,000	1664-187-6598-00	01/01/2007	06/30/2008
Forest Capital Partners LLC	20,000	1664-187-6593-00	01/01/2007	06/30/2008
Blandin Paper Company	20,000	1664-187-6597-00	01/01/2007	06/30/2008
Plum Creek	20,000	1664-187-6595-00	01/01/2007	06/30/2008
MN DNR	200,000	3005-10414-00005642	06/26/2008	06/30/2009
State of Minnesota	20,000	3005-10414-00005615	07/01/2007	06/30/2009
Plum Creek Timber Company, Inc	20,000	3000-10414-00007251	12/01/2008	12/31/2009
Minnesota Power	20,000	3000-10414-00006971	12/17/2008	12/31/2009
Blandin Paper Company	20,000	3000-10414-00006973	12/01/2008	12/31/2009
Potlatch Corporation	20,000	3000-10414-00006975	12/01/2008	12/31/2009
Verso Paper	20,000	3000-10414-00006976	12/01/2008	12/31/2009
St Louis County	20,000	3003-10414-00011548	07/01/2009	06/30/2010
Minnesota Power	20,000	3000-10414-00015985	03/23/2010	06/30/2010
Forest Capital Partners, LLC	20,000	3000-10414-00006974	12/05/2008	12/31/2010
Plum Creek Timber Company, Inc	20,000	3000-10414-00015982	01/01/2010	06/30/2011
Potlatch Corporation	20,000	3000-10414-00015980	01/01/2010	06/30/2011
MN DNR	20,000	3005-10414-00012900	09/03/2009	06/30/2011
Verso Paper	20,000	3000-10414-00015981	01/01/2010	06/30/2011
Total	$1,240,000			

Start Date: 10/28/2004 **End Date:** 06/30/2011 **Project ID:** 1363

Biotechnology Initiative

Prairie Grass Characterization

Objective

To work in collaboration with Carl Rosen at the University of Minnesota Twin Cities for basic biomass characterization of prairie grass.

Background

Biomass derived feedstocks for gasification and combustion may be a viable option for power generation in the future, yet they also have inherent difficulties. Biomass, specifically herbaceous biomass such as prairie grass, typically has high ash and chlorine content along with problematic characteristics such as low melting point compounds in their ash. A biomass characterization procedure for prairie grass will be conducted to analyze its chemical makeup and potential for energy production.

Previous Activity

Basic biomass characterization will be used as a baseline for potential combustion and/or gasification testing at the Coleraine Minerals Research Lab (CMRL). Other research may arise from the characterization and testing. Analyses include moisture content, thermogravimetric analysis(TGA), loss on ignition (LOI), ash chemistry analysis, carbon-sulfur, and calorimetry.

Current Activity

Analysis of the different prairie grass plots included moisture content, thermogravimetric analysis(TGA), loss on ignition (LOI), ash chemistry analysis, carbon-sulfur, and calorimetry. These findings will be analyzed, and future gasification and/or combustion tests may occur. Densification parameters and procedures for the material must also be finalized before proceeding.

Principal Investigator(s)

Matthew Mlinar

Project Sponsor(s)	Amount	Account	Active	
Xcel Energy		3000-11024-00001957	08/25/2008	10/22/2013
Total	$			

Start Date: 12/01/2010 **End Date:** 10/22/2013 **Project ID:** 1640

Biotechnology Initiative

Torrefied Biomass as a Partial Replacement Fuel for Taconite Induration

Objective

To conduct a series of roasting tests to determine the parameters required to produce a biomass char applicable to Minnesota mining industry combustion systems.

Background

Torrefaction of biomass is an effective method to improve the grindability of biomass to enable more efficient co-firing with fossil-based fuels. It can then be used as a complete, or more likely partial, replacement for coal in pulverized coal facilities.

Previous Activity

It was planned that tests would be done in a pilot scale roasting kiln set up at the Coleraine Minerals Research Laboratory (CMRL), which has been designed to process between 4-20 lbs/hr of biomass feed materials. Testing would be done to define the feed characteristics (moisture, size, etc.), temperature, and residence time required for subsequent grindability tests to optimize the degree of torrefaction required. Bio-char products will be characterized according to carbon, ash, and sulfur content. Further evaluation of the bio-char will also be conducted using Thermal Gravimetric Analysis (TGA) that has been designed to accommodate significantly larger samples of bio-products for temperature-weight loss characteristics, ash analysis, and product gas characterization. In addition, to efficiently use biomass char as a fuel for taconite induration, the energy content of the by-product gas must also be utilized. Characterization of the off-gas will be used to determine further applicaton as a fuel to either conduct the torrefaction process or as a supplement to the current burner combustion system. The torrefier device was retrofitted from existing equipment at CMRL, with the addition of new heating elements, controls, and associated components. Initial testing of device capabilities and raw feed chemistry was planned to be done first. These baseline figures will be used to compare against different heating schedules, Hardgrove Grindability tests, and further chemistry analyses. Off-gas analysis will be conducted during torrefier runs, as well as from the custom thermogravimetric analyzer (TGA) located at CMRL.

Current Activity

The calciner torrefier was used to generate enough torrefied wood samples for chemistry, calorimetry, ash chemistry, thermogravimetric analysis (TGA), and grindability studies. Three different temperatures were chosen to represent severe, moderate, and mild torrefaction; the temperature setpoints of 300, 275, and 250 degrees Celsius correlated with a dry solids loss (DSL) of approximately 32%, 28%, and 18%, respectively. Calorimetry and grindability tests were also conducted on 10%, 20%, and 30% replacement tests with coal. The torrefied wood showed an increase in grindability, energy density, total carbon content, and ash content. Furthermore, off-gas analysis was conducted using gas analyzers and gas chromatography. The permanent gas portion of the off-gas consisted mainly of carbon dioxide and carbon monoxide, whereas the condensable portion consisted of a numerous amount of compounds.

Principal Investigator(s)

Matthew Mlinar
Richard Kiesel

Project Sponsor(s)		Amount	Account	Active	
MN DNR		35,737	3005-10417-00014215	05/01/2010	06/30/2011
	Total	$35,737			

Start Date: 05/01/2010 **End Date:** 06/30/2011 **Project ID:** 1630

Chemical Extractives

Design of Novel Triterpene-based Anticancer Chemotherapeutics

Objective

To synthesize and characterize a panel of bifunctional quaternary-amino triterpenoid derivatives and to provide screening of newly synthesized molecules for effects on cancer cell proliferation and for general toxicity (cell death).

Background

A panel of bifunctional quaternary-amino triterpenoid derivatives has been synthesized and characterized by Dr. Krasutsky's group in the Laboratory of Chemical Extractives, NRRI. Subsequently, these compounds have been screened for effects on cancer cell proliferation and for general toxicity (cell death) in the laboratory of Dr. Jon Holy, UMN Department of Medicine. Compounds representing a range of potencies were selected and applied to a mouse tumor-stroma in vitro model of breast cancer, consisting of 4T1 mouse breast carcinoma cells genetically engineered to express green fluorescent protein (GFP), and normal fibroblasts isolated from mouse mammary glands.

Previous Activity

A paper entitled "Dimethylaminopyridine derivatives of lupane triterpenoids are potent disruptors of mitochondrial structure and function" was composed and published in the Journal of Bioorganic & Medicinal Chemistry 18(2011), pages 6080-6988.

Current Activity

Preparation is ongoing for publication of a paper entitled "Pyridine Derivatives of Lupane Triterpenoids Are Potent Disruptors of Mitochondrial Structure and Function" in the Journal of Bioorganic & Medicinal Chemistry.

Principal Investigator(s)

Pavel Krasutsky

Project Sponsor(s)	Amount	Account	Active	
Whiteside Institute for Clinical Researc	7,500	3006-10419-00024253	01/01/2011	12/31/2011
Total	$7,500			

Start Date: 01/01/2011 **End Date:** 12/31/2011 **Project ID:** 1642

Chemical Extractives

Processing DDGS into Biofuels and Other Value-Added Products - Pilot Development and Commercialization

Objective

To develop and optimize parameters to process DDGS into an array of value-added products at lab, bench, and pilot scales with the subsequent commercialization and marketing of the value-added products.

Background

Minnesota's corn ethanol industry produces millions of tons of a lower value co-product called Dried Distillers Grains and Solubles (DDGS) that is marketed as a feed product. It has been determined that the components of DDGS can be selectively extracted yielding a liquid fraction (oil and solubles) and a solid fraction (a higher protein distillers grain).

Previous Activity

Scientists in the Chemical Extractives Program at NRRI's Center for Applied Research and Technology Development (CARTD) have spent the previous few years working on optimization of parameters to extract oils and solubles from DDGS to make the process cost- and energy-efficient. These parameters include, but are not limited to, time, temperature, solvent, and equipment choice. Enough progress has been made to permit successful up-scaling of procedures from the laboratory to near-industrial.

Current Activity

Major progress has been made in the ablity to process bulk quantities of DDGS (1000+ lbs.) in either batch or continous processes. This work has been conducted with the cooperaton of our partners at Heartland Alliance and Crown Iron Works. Consistency of the input product, process parameters, and value-added output products has allowed for creation of a marketing and commercialization plan that has been met with interest by industry and agricultural organizations.
Work on processing the liquid fraction of the extraction process has also progressed and will be the subject of further disclosure in cooperation with the University's Office for Technology Commercialization (OTC).

Principal Investigator(s)

Pavel Krasutsky

Project Sponsor(s)	Amount	Account	Active	
MN Initiative for Renew Energy&Env(IREE)	250,000	1780-10419-21314-100000	07/01/2010	06/30/2013
Total	$250,000			

Start Date: 07/01/2010 **End Date:** 08/30/2011 **Project ID:** 1595

Minnesota`s Geothermal Energy Production

Objective

To (1) Collect downhole temperatures from over 100 water wells and exploration drill holes; (2) Collect, analyze, and describe 100 granite samples; and (3) Issue a final report with the new heat flow and temperature vs. depth maps.

Background

Enhanced Geothermal Systems (EGS) for future energy recovery are primary technologies needed for future electrical power and/or thermal heat production systems. The U.S. DOE in their 2007 study conducted by MIT concludes EGS extraction is one of the most promising clean energy technologies that can be used nationwide. EGS could provide 100 GWe (gigawatt - electric) or more of cost-competitive generating capacity in the next 50 years at sites throughout the U.S.A. where geothermal heat transfer conditions, rock stability, and appropriate hydrothermal environments are present at depths greater than 5 km. However, the heat flow and temperature versus depth maps in the DOE-MIT report indicate that temperatures at depth in Minnesota (MN) are very cold, based on four data points within Minnesota and about 90 data points under Lake Superior. All but one of these data points were collected 2.5 meters under lakes. Temperatures at shallow depths are affected by climate, and recent research shows that temperatures begin to stabilize at about 300 ft. or 100 meters, which eliminates all but one of the previous data points.

Previous Activity

Collecting downhole temperature data was limited due to equipment malfunctions. However, collection of granite samples from drill core at the DNR Drill Core Library in Hibbing and in outcrop for thermal conductivity, radionuclide analyses, whole rock, and trace element geochemical analyses continued. These samples and any additional samples collected in Jan-March 2011 will be sent out for the above analyses. Polished thin section preparation and finishing will occur in April 2011. These granite and other rock samples are an integral part of determining the heat flow in MN.

Current Activity

Downhole data acquisition increased during the period with the purchase of a Mt. Sophris downhole probe and related equipment. A second team was added to locate new wells ahead of the downhole survey team. Thermal conductivity analyses were completed at UND-Grand Forks, and a contour map was produced showing areas of high conductivity (where heat flows the fastest), particularly in west-central MN. In conjunction with this map, the downhole temperature data collected during this period were added to previous data so as to make a new contoured heat flow map. There is now an area that trends from west-central MN northeast (International Falls area) that has higher heat flow than the original heat flow map of MN. All of the above data indicate that this study has so far elevated the heat flow under MN by 12% over previously reported heat flow data. Granite chemistry was received and evaluated for uranium and thorium content. A few elevated samples for the data population are associated with areas that contain alkaline igneous rocks.

Principal Investigator(s)

Donald Fosnacht
Steven Hauck

Project Sponsor(s)	Amount	Account	Active	
MN Department of Commerce	300,000	3005-10416-00013310	11/02/2009	01/31/2012
PUF Mineral Endowment	40,000	1750-10416-20090-100000	08/25/2009	06/30/2012
State of Arizona (USDOE Prime)	20,349	3014-10416-00020610	05/24/2010	08/28/2012
Total	$360,349			

Start Date: 11/02/2009 **End Date:** 09/30/2011 **Project ID:** 1580

Polymetallic Gas to Liquid Catalysts

Objective

To conduct research and development to produce novel catalysts for thermochemical processing of biofuels based on local mineral sources.

Background

Recent publications show the significant potential of polymetallic catalysts in Fischer-Tropsch Reaction and related processes. Compared to the traditional pure iron or cobalt formulations, modification of iron catalysts with copper, chromium, titanium, manganese and/or others gives better conversion, improves the lifetime of the catalyst, positively influences the "C5+" selectivity and other parameters. Preparation of polymetallic catalysts requires multistep procedures to obtain the proper composition. On the other side, a number of minerals available for mining in Minnesota, such as ilmenite and magnetite, already contain the necessary metals in good proportion alongside the proper carrier compounds. These minerals may show the catalytic activity, and may be valuable for gas to liquid technology.

Previous Activity

Catalysts for conversion of Syngas to liquid fuels were made on a base of the local mineral ilmenite. Processing of these catalysts, identified as polymetallic ferrotitanates, is cost and labor saving, compared to common procedures of catalyst preparation. The process is comprised of klinkering ilmenite with sodium or potassium carbonates, followed by water-leaching the klinker. The named catalysts were found suitable for the conversion process of syngas to hydrocarbons. This is known as the Fischer-Tropsch reaction. A systematic study proceeded with conversion of low-hydrogen (below 50% H2) syngas, since this composition is typical for syngas obtained from biomass. Ilmenite-based catalysts, doped with copper or cobalt, show sufficient activity in the named reaction, comparable to the activity of commonly known precipitated and supported catalysts. It was also found that CO2/H2 blends can be converted to a hydrocarbon mixture in the presence of the named catalysts. The effects of dope metals on reaction rates and on the composition of final products have been explored. Certain kinetic studies have also been done.

Current Activity

Study has continued in regard to testing the ilmenite-based catalysts in the liquid phase (stirred tank reactor) arrangement. A number of comparative tests have been done on syngas conversion over ferrotitanate catalysts, doped with various amounts of copper, cobalt and extra iron. It was found that the named catalysts are suitable for the liquid phase process. Conversion factors for the low-hydrogen syngas in the stirred tank reactor are in the range of 60-95% CO per single pass, depending on process conditions. Product composition depends on the type and proportion of dope metal in the catalyst, in mainly the same manner as previously found for the gas phase process (cobalt-doped catalysts give higher amounts of isomeric hydrocarbons in the product stream). In separate lab tests, it was also discovered that some of ferrotitanate catalysts are effective for reduction of CO and NOx content in boiler flue gas.

Principal Investigator(s)

Andriy Khotkevych
David Hendrickson
Richard Kiesel

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		190,000	1896-783-1239-00	02/29/2008	06/30/2012
	Total	$190,000			

Start Date: 02/29/2008 **End Date:** 06/30/2012 **Project ID:** 1500

Energy

Pumped Hydro Energy Storage (PHES) Using Abandoned Mine Pits on the Mesabi Iron Range of Minnesota

Objective

The Mesabi Iron Range has been mined for over 100 years. In doing so, a large number of open pits and underground mines were created along its 120 mile length. This project's main question is – what potential pumped hydro energy storage sites on the Mesabi Iron Range would support a closed-loop pumped hydro energy storage facility, and can the facility be constructed in an environmentally sound manner?

Background

PHES facilities are constructed to add stability to a local or regional energy grid, i.e., no peaks or valleys in the amount of electricity available to all consumers. These energy storage facilities are constructed using an upper reservoir, which is twice the size of the lower reservoir. Water is released from the upper reservoir through penstocks, which carry the water to the turbine(s) that produce the electricity. Generally, water is released during the day and pumped back to the upper reservoir during the night. The "head" (difference in elevation between the upper reservoir and the top of the lower reservoir) needs to be a minimum of 350 ft. These are basic criteria for locating a facility on the Mesabi Iron Range. Other criteria such as environmental impact, land ownership (surface and minerals), wetlands, archaeological sites, engineering and geotechnical considerations, etc., all impact the siting of a PHES facility.

Previous Activity

Selected members from the various project teams, e.g., Facilities, Environment, Geotechnical, and Policy, along with project members from Great River Energy and Minnesota Power, traveled to a PHES facility in Ludington, Michigan. Consumers Power Co. provided a great tour of their facility and allowed the group to learn more about the processes and equipment involved in producing energy. The teams also had a day-long meeting at Barr Engineering in Hibbing, MN, which covered PHES work that Barr had previously done at seven sites on the Mesabi Iron Range.

Current Activity

All four teams actively pursued their work plans for this IREE sponsored project. Results of this work have shown that various scenarios can be used to adopt this energy storage strategy for various locations on the Mesabi Iron Range. The Environmental team has gone through typical items that would be important for an Environmental Impact Statement (EIS) to be developed, and they have interviewed various stakeholders about their environmental concerns. The Policy team conducted extensive interviews to gauge public acceptance and potential roadblocks to concept implementation. The St. Anthony Falls Laboratory has identified structural and equipment requirements for a model facility, and the Geotechnical team has characterized the structural conditions that may exist at various locations across the Range in terms of rock integrity and overall rock quality. A final report for this project will be issued at the end of October.

Principal Investigator(s)

Donald Fosnacht
Elizabeth Wilson
Jeffrey Marr
Nathan Johnson
Steven Hauck

Project Sponsor(s)	Amount	Account	Active	
MN Initiative for Renew Energy&Env(IREE)	50,000	1780-10413-21314-100000	07/01/2010	09/30/2011
MN Initiative for Renew Energy&Env(IREE)	15,000	1780-10413-21314-100000	07/01/2010	09/30/2011
MN Initiative for Renew Energy&Env(IREE)	70,000	1780-10413-21314-100000	07/01/2010	09/30/2011
MN Initiative for Renew Energy&Env(IREE)	55,000	1780-10413-21314-100000	07/01/2010	09/30/2011
MN Initiative for Renew Energy&Env(IREE	60,000	1780-10413-21314-100000	07/01/2010	09/30/2011
PUF Mineral Endowment	35,000	1750-10416-20090-100001	08/25/2010	06/30/2012
Total	$285,000			

Start Date: 07/01/2010 **End Date:** 06/30/2012 **Project ID:** 1592

Environmental Chemical

Distribution of Mercury During the Processing of Copper-Nickel Ores

Objective

To determine the distribution of mercury during flotation and subsequent pressure leaching of the bulk flotation concentrate.

Background

The development of a copper-nickel mine and processing plant would be a large economic boost to the area. The proposed development area is within the Lake Superior Basin, which is an environmentally sensitive area. Therefore, mercury in the ore and resultant concentrates and tailings will be of great concern. Preliminary analyses of analytical laboratory pulps from previous copper-nickel studies indicated a mercury concentration in the head sample of 65 nanograms per gram (ng/g) (or parts per billion - ppb) and 108 ng/g in a flotation concentrate sample. It should be noted that the samples had been previously pulverized (no effort to prevent mercury contamination) and had been stored in paper envelopes for as long as nine years prior to analyses. While the absolute values of the above analyses may be suspect, they do indicate the presence of mercury in the ore and in the concentrate.

Previous Activity

When sufficient concentrate becomes available, the autoclave leaching tests will be conducted.

Current Activity

The autoclave is being refurbished. When the update is completed, work will start on making the necessary concentrate for leaching tests. Following the leaching tests, the PGMs (Platinum Group Metals) in solution will be precipitated with sodium sulfide addition. It is anticipated that essentially all the mercury will also precipitate as mercury sulfide.

Principal Investigator(s)

Blair Benner

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		18,750	1896-783-1203-00	02/09/2005	06/30/2011
	Total	$18,750			

Start Date: 02/09/2005 **End Date:** 12/30/2011 **Project ID:** 1381

Environmental Chemical

Full Scale Mercury Sorbent Testing at Boswell

Objective

To run a full scale sorbent addition test on Unit 1 at Minnesota Power`s Boswell Energy Station in Cohasset, Minnesota. One or more mercury removal sorbents developed at the Coleraine Minerals Research Laboratory (CMRL) will be injected as dry sorbents into the 75 megawatt (MW) unit`s 250,000 cubic foot/meter (cfm) stack gas stream prior to the unit`s baghouse. Stack gas mercury measurements will be conducted before and after the sorbent addition to evaluate the efficiency of mercury removal.

Background

Three years of mercury removal research test work, utilizing funding from an Economic Development Agency (EDA) grant and the Permanent University Trust Fund (PUTF), has shown that chemically modified iron ore concentrate is an effective sorbent for the removal of oxidized and elemental forms of mercury in a 250 cfm flue gas slip stream from Unit 4 at Minnesota Power's Boswell Generating Station in Cohasset, Minnesota. NRRI-developed sorbents were shown to remove greater than 90% of total mercury at pilot scale in the stack gas stream. Previous test work has shown that it is possible to efficiently separate the sorbent from the fly ash. The mercury sorbent is capable of being reused and reinjected back into the gas stream for additional mercury removal. Sorbent regeneration work has shown that it is possible to remove greater than 90% of the total mercury from the "loaded" sorbent by heating in an inert atmosphere on a batch basis. Volatilized mercury can then be condensed and totally removed from the environment. Attempts to remove the mercury on a continuous basis, using an indirectly fired calciner, have shown that temperature control is critical to efficient removal. In addition to plant test work, computational fluid dynamics analysis of duct work in Unit 1 was also conducted at CMRL to design an efficient dry sorbent injection system, ensuring good gas-sorbent contact.

Previous Activity

Discussions were planned with Minnesota Power to conduct new mercury reduction test studies on Unit 4 stack gas. After review with Boswell Unit 4 process engineers, pilot scale test work will be conducted to evaluate wet removal of elemental mercury in the wet scrubber system.

Current Activity

Full scale sorbent testing on the Boswell Unit I 200,000 cfm stack emissions has not yet been accomplished, since a low cost pilot scale mercury reduction technology was not yet achieved that would provide adequate reduction of the elemental mercury present in the discharge stack gas. New chemical oxidation and/or nano-solid sorbent mercury removal technologies will be tested in 2011 to accomplish a full scale mercury reduction test in 2012. Since wet scrubbers are being phased out of pollutant control technologies for coal fired power plants, our research emphasis is focused on mercury reduction technologies applied to bag house fly ash removal techniques.

Principal Investigator(s)

Blair Benner
David Hendrickson

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		350,000	1896-783-1227-00	04/10/2007	06/30/2012
	Total	$350,000			

Start Date: 04/10/2007 **End Date:** 06/30/2012 **Project ID:** 1476

Environmental Chemical

Investigation of Mercury Vaporization During Induration, and Removal of Mercury from Scrubber Solids

Objective

To determine how mercury is volatilized during induration and to investigate methods of removing mercury from the scrubber solids.

Background

The taconite industry is under pressure to reduce the emissions of mercury from their induration process. Previous studies have shown that greater than 90 percent of the mercury in the green balls is vaporized during induration. What is not known is whether the mercury is vaporized quickly, early in the process, or is slowly evolved over the entire process. Once the temperature-time relationship for mercury volatilization is established, then it may be possible to treat a smaller portion of the gas stream to remove mercury. Previous studies have shown that the fine solids removed by the scrubbers contain mercury, which is recycled back to the indurating furnace. The solids cannot be simply discarded without a significant loss in iron units. However, if the solids could be treated to remove the mercury, then they could be recycled to recover the iron and still reject mercury.

Previous Activity

When the necessary equipment is available, work will begin to determine if bromine salts added to green balls can increase mercury oxidation.

Current Activity

Bromine salts have been procured. The mini-pot is currently down for repairs. When the pot has been repaired, it is planned that green balls with and without bromine salts will be produced and fired.

Principal Investigator(s)

Blair Benner

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		45,500	1896-783-1200-00	02/09/2005	06/30/2011
	Total	$45,500			

Start Date: 02/09/2005 **End Date:** 12/30/2011 **Project ID:** 1378

Mercury Reduction Tests - Bench/Pilot Scale - Western Lake Superior Sanitary District

Objective

To reduce the level of total mercury in the Western Lake Superior Sanitary District`s discharge water from two parts per trillion to one part per trillion for Duluth's 40 million gallon per day wastewater treatment plant.

Background

As the new discharge limits for mercury in waters being discharged into Lake Superior have been reduced by the Minnesota Pollution Control Agency, the Western Lake Superior Sanitary District (WLSSD) needs to reduce to one part per trillion the mercury in their discharge water which flows into Lake Superior. WLSSD is Duluth's 40 million gallon per day wastewater treatment plant located in west Duluth along the Lake Superior waterfront.

Previous Activity

Bench scale work was scheduled to continue during the spring of 2009 to support the continuing effort requested by WLSSD to reduce its water discharge mercury levels to below 1.30 parts per trillion (ppt) total mercury. NRRI is part of a mercury reduction team assembled by WLSSD to continue bench and in-plant mercury reduction work at their waste water treatment plant. Previous in-plant test work showed relatively low mercury removal, therefore, WLSSD is seeking a more effective mercury reduction in-plant process. It was planned that new chemical design research would be tested in early 2009 to evaluate its mercury removal efficiency, and also that the mercury reduction team formed by WLSSD would meet in the summer of 2009 to initiate new test work described by the team. NRRI planned to test new mercury sorbents to remove oxidized and elemental mercury forms in WLSSD's discharge waters in the fall of 2009 and spring of 2010. Could they remove 2 ppt total mercury as they are placed in the sand section of the plant's final carbon/sand filter which filters the plant's discharge water? Mercury removal test work was rescheduled to the fall of 2010 to test the ability of new mercury sorbents to lower total mercury in WLSSD's discharges from 2ppt to less than 1.3ppt.

Current Activity

Work on aqueous mercury reduction in WLSSD discharge waters pumped into Lake Superior was completed. Oxidized forms of mercury were reduced to elemental mercury using aqueous reductant chemicals followed by volatilization and air stripping of the elemental mercury from discharge water. This mercury reduction process did not achieve the desired reduction of 2.0ppt total mercury to the required point source discharge limit of 1.3ppt in their discharge water. The next approach utilized floccullant chemicals to try to precipitate out low levels of organic mercury thought to be present in the WLSSD discharge. This process also did not achieve the required reduction in total mercury from an average of 2.0ppt total mercury to the target level of less than 1.3ppt total mercury.

Principal Investigator(s)

David Hendrickson

Project Sponsor(s)	Amount	Account	Active	
Western Lake Superior Sanitary District	44,048	1933-187-6583-00	06/02/2006	12/31/2007
Total	$44,048			

Start Date: 06/02/2006 **End Date:** 06/30/2011 **Project ID:** 1428

Environmental Chemical

Slip Stream Pilot Plant for Testing Mercury Removal Methods for Taconite Flue Gases

Objective

To design and install a slip stream pilot plant at one of the taconite plants so that various mercury removal methods can be evaluated using real plant gases.

Background

Taconite plants are currently considered to be the second largest mercury emitters in the state. While millions of dollars have been spent on research and plant trials regarding mercury removal from power plant flue gases, relatively little has been done on taconite gases. With the large differences between the power plants and taconite plants, it is not clear that methods effective in power plants will be as effective in taconite plants. A slip stream is a more economical way to evaluate a relatively large number of alternatives without having the balance of the plant issues.

Previous Activity

NRRI engineers and technicians met and conducted on-line continuous speciated mercury analysis baseline testing at Minnesota taconite operations. Additional baseline testing was planned for the fall of 2010. NRRI researchers were also chosen in conjunction with researchers from the University of North Dakota's (UND) Energy and Environmental Research Center (EERC) to participate in mercury removal research for taconite operations. Preliminary test work will be conducted at CMRL, followed by larger scale tests using pellet plant stack gas emissions. In-plant research work was planned at several Minnesota taconite operations using mercury reduction techniques developed at EERC.

Current Activity

A new pulse jet bag house pilot scale system is being installed on the 250 cfm slip stream that we have developed from Boswell Unit 4 on the wet scrubber feed stream. Research efforts will focus on elemental mercury reduction for the bag house technology, which follows new mercury reduction technology installed on Boswell Unit 3.

Principal Investigator(s)

Blair Benner

David Hendrickson

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		350,000	1896-783-1228-00	04/10/2007	06/30/2012
	Total	$350,000			

Start Date: 04/10/2007 **End Date:** 06/30/2012 **Project ID:** 1477

Environmental Remediation

Erie Pier Dredged Material Beneficial Use Study

Objective

(1) Identify landowners willing to participate in demonstration projects and receive fine grained dredged material for restoration demonstrations.
(2) Evaluate the cost and feasibility of using rail transportation to move Erie Pier fine grained dredged material to potential recipient sites.
(3) Provide monitoring and results analysis of vegetative health, plant diversity and control of purple loosestrife for demonstration sites.
(4) Evaluate the effectiveness of using microwave technology to sterilize seeds contained in Erie Pier fine grained dredged material.
(5) Conduct a laboratory and field assessment of the stamp sand area near Gay, Michigan, within the context of this location being a potential recipient site for navigation channel material from the Duluth-Superior harbor and/or Erie Pier for establishing stamp sand-stabilizing vegetative cover.

Background

The University of Minnesota Duluth Natural Resources Research Institute (NRRI) is working with the U.S. Army Corps of Engineers (COE) to evaluate beneficial use of Erie Pier fine grained sediment dredged from the Duluth-Superior harbor and stored at the Erie Pier facility located in Duluth Minnesota. The Erie Pier facility will reach its engineered design capacity within the next five years. Consequently, finding small, medium, and large-scale sites for beneficially reusing the materials stored at Erie Pier is an important goal. The current study is evaluating potential beneficial uses for the sediment within approximately a 60-90 mile radius of Erie Pier, in part as it relates to mine land usage. The project was several components that will address the objectives listed previously.

Previous Activity

This is a new project.

Current Activity

Project work began in February 2011, focusing on identification of potential recipient sites for small-scale near-term demonstrations, and for longer-term, larger-scale usage. NRRI has nearly completed work on a GIS database and map of prospective landowners/recipient sites. NRRI facilitated meetings with personnel from the City of Superior, and also the Wisconsin Departments of Natural Resources and Transportation in the spring of 2011. These discussions led to permits being obtained from both MDNR and WDNR to allow 1,000 cubic yards of fine-grain dredge materials from Erie Pier to be trucked to the Moccasin Mike Landfill in Superior, Wisconsin, to reestablish turf in an upland area disturbed during a sewer installation project. Reception of the fines marked the first time that any city in Wisconsin had been cleared to use and transport this kind of sediment across state lines. As part of this pilot project, the City of Superior is conducting a weed survey to identify any noxious weeds that may germinate in the sediment at the test site.

Principal Investigator(s)

Lawrence Zanko
Steven Hauck

Project Sponsor(s)	Amount	Account	Active	
USDOD Army Corps of Engineers	187,500	3002-10416-00021820	01/24/2011	12/31/2012
Total	$187,500			

Start Date: 01/24/2011 **End Date:** 12/31/2012 **Project ID:** 1612

Closing the Loop on Filter Cake Moisture Analysis and Control

Objective

To determine what the best and least expensive on-line moisture analyzer and associated sampling system is and then how best to structure the actual moisture control loop program to achieve constant filter cake and green ball moisture.

Background

Previous test programs conducted by taconite plants and R&D laboratories have evaluated various on-line filter cake moisture analyzers, yet have not identified any analyzer that gives accurate and reproducible moisture data.

Previous Activity

Programming was ongoing for the NRRI moisture analysis system using Allen Bradley DeviceNet communications and an Allen Bradley Programmable Logic Controller (PLC). Design components were built into the system to make it capable of future automation in a taconite plant so as to create an automated on-line filter cake moisture analysis system. Work progressed to complete the system with PLC installation. It was planned that a new electrical engineer at the Coleraine Minerals Research Laboratory (CMRL) would begin assembling the components for bench scale testing, and that the unit would be tested in manual mode prior to advancing to a PLC operating mode.

Current Activity

Project work was completed for developing an automated filter cake drying system based upon housing a large capacity scale in the base of a convection type drying oven in order to create an automated high capacity moisture balance for measuring filter cake moisture. Filter cake samples as large 2000 grams were analyzed to a 2 sigma accuracy of 0.02% moisture. Current discussions with Minnesota taconite operations favored a more automated on-line filter cake moisture analysis system, which is now being designed. The planned design incorporates diversion of filter cake samples off production conveyor belts onto a weigh belt scale system equipped with banks of heaters to accomplish dynamic weighing, drying, and reweighing of the filter cake sample. New weigh belt equipment affords accurate measurement of filter cake moisture on moving belt systems. A new PUTF project will be created to demonstrate this new advancement in technology.

Principal Investigator(s)

David Hendrickson
Kyle Bartholomew
Matthew Mlinar
Richard Kiesel

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		88,800	1896-783-1060-00	02/01/2002	06/30/2011
	Total	$88,800			

Start Date: 02/01/2002 **End Date:** 06/30/2011 **Project ID:** 1181

Coleraine Lab Standards

Objective

To establish new laboratory standard samples for regulation of standardized procedures and calibration of equipment and instrumentation.

Background

The previous lab standard was collected and prepared in 1986, and is commonly referred to as the Coleraine 9-barrel standard. Several barrels of fired pellets were collected from a local taconite plant and were screened to remove fines, resulting in nine barrels of +1/4" pellets. These pellets have served as a lab standard for almost 25 years, and we are now down to the last 5-gallon pail. Fired pellet standards are routinely run to ensure that equipment and procedures are reliable.

Previous Activity

Two fired pellet and one iron ore concentrate standard were collected and prepared as follows: 1) acid pellet, 2) flux pellet, and 3) acid
concentrate. The pellets were split and blended to ensure that each barrel collected was identical and that they were representative of each other. Each barrel of pellets was then analyzed to ensure that the sample was reliable and uniform. Fired pellets were tested using ASTM, ISO and lab standardized procedures to establish an acceptable statistical mean and standard deviation. This was done for each pellet sample to establish both an acid and a flux pellet standard. Essentially the same technique and procedure was used on the iron ore concentrate. It was split, blended, mixed and analyzed using a standardized set of screens
to ensure that it was uniform and reliable. Fired pellet samples were collected, split and analyzed. Baseline data were recorded, and data were analyzed for full determination of statistical mean and standard deviation.

Current Activity

Final metallurgical quality test results for ISO 4695, Fired Pellet Reducibility (R40) are in progress. A scale bias noted on the R40 test resulted in delays to complete the testing. The equipment has been calibrated, and verification of the test parameters are being analyzed for consistency.

Principal Investigator(s)

Matthew Mlinar
Richard Kiesel

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		12,000	1750-10417-20090-100001	11/19/2010	06/30/2012
	Total	$12,000			

Start Date: 11/19/2010 **End Date:** 06/30/2012 **Project ID:** 1636

Continuation of the Concentrator Modeling Center at CMRL

Objective

To re-establish concentrator modeling capabilities at the Coleraine Minerals Research Laboratory (CMRL).

Background

Over the past ten years, under the direction of Dr. Salih Ersayin, the Concentrator Modeling Center has provided invaluable services to the taconite industry. Numerous taconite specific models have been developed and successfully applied in the plants. These models are unique to the modeling Center at CMRL. Since Dr. Ersayin's departure, however, the Center has been unable to supply these services. A new program director for the modeling Center has been hired and will require time to get up to speed on the taconite models and needs of the industry.

Previous Activity

The modeling Center's new Program Director, Dr. E. Caner Orhan, was scheduled to begin work at the Center during March 2010. It was planned that he would be introduced to the Center's version of USIM PAC and to taconite industry contacts. It would be necessary for him to become familiar with the previous work of the Center so that he would be able to demonstrate proficiency in modeling the various concentrators on the Iron Range. Dr. Orhan began working at the Center in March 2010. At that time, previous concentrator modeling work and projects were reviewed, and various concentrators on the Iron Range were visited. The modeling and simulation software, USIM PAC, together with plant data available at the Center were examined. Work began on well-known and robust equipment models that had not previously been included in USIM PAC to integrate them into the software. This would enable re-evaluation and cross-checking of predictions made by USIM PAC's built-in models. New concentrator models were developed for new, potential magnetite ore mining operations.

Current Activity

New concentrator models were developed for new magnetite operations, and CMRL is seeking to hire a new concentrator modeling engineer to advance the concentrator modeling Center.

Principal Investigator(s)

Blair Benner

Eren Caner Orhan

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		75,000	1896-783-1220-00	07/16/2006	06/30/2011
	Total	$75,000			

Start Date: 07/16/2006 **End Date:** 06/30/2012 **Project ID:** 1581

Minerals, Ferrous

Converting Mining Waste Rock to Passive Solar Tiles

Objective

To demonstrate that tiles made from a locally produced mining waste can be aesthetically pleasing and efficient as the solar absorber in a passive solar heating system.

Background

Passive solar heating has the potential to benefit the environment by displacing fossil fuel use for space heating in residential and commercial structures. To capture the benefits of passive solar heating, consumers will have to be persuaded to choose it over competing space heating technologies. Some of the factors influencing customer choice include aesthetics, efficiency, and the environmental impact of the product.

Previous Activity

During this period, the project was initiated. Initial test solar absorbing tiles were cast using a base recipe. Small-scale tiles were also cast, varying the recipe to check feasibility of fabrication. A prototype air heater was designed and fabrication was started. Instrumentation needs were identified and ordered. It was expected that the prototype would be operational in January 2011. A poster presentation summarizing the project was made at the IREE conference in November 2010.

Current Activity

The pilot unit was fabricated and put into operation. Initial data were collected indicating a 50°F increase in exhaust air temperature over inlet air temperature. Production runs were completed to make tiles for a larger scale air heater. The larger scale air heater was fabricated with a collection area of about 4.5 square meters.

Principal Investigator(s)

Kyle Bartholomew

Project Sponsor(s)	Amount	Account	Active	
MN Initiative for Renew Energy&Env(IREE)	50,000	1780-10417-21314-100000	07/01/2010	08/30/2011
Total	$50,000			

Start Date: 07/01/2010 **End Date:** 08/30/2011 **Project ID:** 1593

Development of Engineered Tiles with Radiation Absorbing Properties from Taconite Raw Materials

Objective

To determine the feasibility of producing architectural quality tiles with unique engineering attributes from taconite iron ore raw materials. The tiles will be produced through high temperature melting in a plasma melting system provided by MetalRecovry, sited at the Coleraine Minerals Research Laboratory (CMRL), and tile formation and annealing in other equipment at the same site, also provided by MetalRecovry.

Background

Based on previous test work already conducted at NRRI, it has been shown that taconite rock and magnetite concentrate have radiation absorbing properties, especially for UV and microwave radiation. It is thought that the creation of high density tiles and other consolidated products will result in material having unique engineering properties. This program will determine the conditions required for making high quality materials and will determine the processing conditions that will allow enhanced radiation absorption properties to be developed.

Previous Activity

The focus of this period of work was on casting non-flat (3D) shapes. To facilitate annealing of these larger pieces, the annealing oven was equipped with a digital temperature controller. It was also rewired to allow the oven to roll-off of its base to accommodate the larger, non-flat pieces. Many different types of molds and materials were tested including dry sand molds, wet sand molds, cast iron molds, refractory molds, terra cotta molds, and graphite molds. A specific recipe of wet sand mold seems to be the best option for cost effectively producing 3D prototypes. Non-flat shapes were also accomplished by a “slumping” process whereby flat tiles are heated to their softening point and allowed to droop over a mold. Operationally, we instituted an argon-based "soft-start” procedure to reduce wear and tear on the torch. We also had to perform a furnace refractory reline due to wear and slag attack.

Current Activity

Most of the plasma furnace runs during this period were dedicated toward making tiles for the IREE solar project. Several three-dimensional pots were fabricated along with flat products. Coal boiler fly ash and bottom ash were used as alternative fluxes for the taconite tailings.

Principal Investigator(s)

David Hendrickson
Donald Fosnacht
Kyle Bartholomew
Lawrence Zanko
Richard Kiesel

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		279,396	1896-783-1241-00	04/28/2008	06/30/2012
	Total	$279,396			

Start Date: 04/28/2008 **End Date:** 06/30/2012 **Project ID:** 1517

Effect of Fluorine and Chlorine on Fired Pellet Metallurgical Properties

Objective

To evaluate the effect of fluorine and chlorine on fired pellet metallurgical properties, specifically Reducibility (R40) and Low Temperature Disintegration (LTD). This will include the influence of halogenated process water for agglomeration and when applied to the surface of fired pellets for the purpose of pellet cooling, conveyor belt protection, and dust control.

Background

Reducibility (R40) and Low Temperature Disintegration (LTD) are established metallurgical tests used to distinguish the quality of iron ore pellets for their performance in the blast furnace. Fired pellet quality has been historically influenced by chlorinated water when applied as dust control or cooling water. Process water containing high levels of chlorine has been shown to be detrimental to metallurgical properties when applied to the surface of cooled pellets. Quenching hot fired pellets for cooling or with conveyor belt protection water is known to degrade metallurgical properties due to the stresses created within the microstructure of the pellet. However, the impact of the chlorine levels in this water must be evaluated. The concentration of these halogens in process water used for agglomeration should also be included in this investigation for its effect on R40 and LTD.

Previous Activity

Data analysis for quenching of fired pellets using halogenated water is complete. Results indicate that compression strength is negatively influenced by quench temperature, fluoride has a negative effect on LTD at elevated quench temperature, chloride has a negative effect on R40 at elevated quench temperature, and fluoride has a negative effect on porosity. Testing of the effects of fluorine and chlorine on agglomeration was planned. Greenballs were to be prepared with varying levels of halogen concentration in the balling water. Minipot firings would be used to determine if a measurable effect on physical pellet quality is detectable.

Current Activity

Statistical analysis, using z-score as a discriminator, was performed on halide data. A fully replicated designed experiment allowed for an estimation of test variability. Varibility was low enough to allow for screening-level conclusions. Agglomeration and firing tests are scheduled.

Principal Investigator(s)

Kyle Bartholomew
Richard Kiesel

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		30,000	1896-783-1075-00	06/01/2003	06/30/2012
	Total	$30,000			

Start Date: 06/01/2003 **End Date:** 06/30/2012 **Project ID:** 1317

Effect of Preheat Burners on a Straight Grate Induration Furnace

Objective

To utilize pot-grate testing to evaluate the effect of adding preheat burners to supplement the thermal energy required when adding low levels of fluxstone.

Background

The addition of low level limestone can have a positive effect on fired pellet quality and can be advantageous to blast furnace iron reduction. The addition of limestone (calcite) to magnetite concentrates requires a significant amount of energy to calcine the fluxstone. This energy "sink" will partially prevent the pellets from reaching an effective induration temperature under normal operating conditions. This is because the calcination reaction takes place at relatively the same temperature as that when the oxidation of the magnetite begins to accelerate (600-800ºC). The CO2 released from the fluxstone fills the pellet pores, inhibiting the diffusion of oxygen into the pellet and slowing the oxidation kinetics. Although the same thermal energy is eventually available, the temperature rise as a result of the oxidation will be slower. Supplemental burners in the preheat section of the furnace may be required to add additional heat during critical stages of induration to maintain production levels and pellet quality.

Previous Activity

Development of a typical straight grate furnace firing cycle was established. Green balls were collected from a commercial balling drum to eliminate any variance associated with balling, and these were then fired as a baseline. It was planned that pot grate tests would be used for comparing the standard firing cycle to one adding additional heat in the pre-heat zone. Pelletizing feed mixtures were prepared containing bentonite binders with 0.3% and 1.2% fluxstone. Mini-pot furnace tests were conducted to observe the effect of additional temperature in the pre-heat section of a straight grate furnace. Pre-heat tests were also conducted with the mini-pot furnace using the same cycles. A pre-heat test is quenched in nitrogen following the preheat stage of induration to stop the oxidation, so as to compare physical quality at this intermittent point in the process. The NRRI-Coleraine Pot Grate Furnace was upgraded with a new combustion system and blower, PLC (Programmable Logic Controller) control, PC-based data collection, flow control/measurement for natural gas, airflow, and oxygen, digital pressure and oxygen measurement, and full temperature recording capabilities.

Current Activity

Full pot grate firings are planned so as to confirm results using temperatures for pre-heat established by mini-pot tests and compared to the previously established baseline. The pot grate hot commissioning and operating procedure development is now complete and the work is in progress.

Principal Investigator(s)

Richard Kiesel

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		25,000	1896-783-1215-00	02/09/2005	06/30/2012
	Total	$25,000			

Start Date: 02/09/2005 **End Date:** 06/30/2012 **Project ID:** 1391

Minerals, Ferrous

Environmental Taconite Particulate Project-Mesothelioma

Objective

To characterize particulates associated with taconite mining in northeast Minnesota, both on the mining properties and in the population centers surrounding the taconite operations. The work being done on the mining properties will support an exposure assessment of taconite workers being performed by University of Minnesota School of Public Health researchers. The community environmental study is an inventory of particulates across the Mesabi Iron Range that can be compared with the particulate characteristics in other locations in Minnesota.

Background

A recent update by the Minnesota Dept. of Health on a cohort of former iron miners from northeast Minnesota reported that in this group there have now been a total of 58 cases of mesothelioma. The report renewed longstanding concerns over the safety of exposure to dust derived from crushing taconite. The State requested the U of MN to take a lead in studying whether the mesothelioma (and possibly other lung diseases) were caused by exposure to taconite dust, as opposed to workplace exposure to commercial asbestos. NRRI will conduct in-plant area sampling and detailed analysis of particulate characteristics. NRRI will inventory particulate characteristics in population centers around taconite operations. The results of the inventory can be used to compare the particulate populations in communities on the Mesabi Iron Range with other towns in Minnesota.

Previous Activity

From July-December 2010, community air sampling took place at Keewatin Elementary School (1 event), on the Mesabi Iron Range, and at the Ely Fernberg site (1 event) and the Duluth NRRI site (8 sampling events) located beyond the limits of the Mesabi Iron Range. Two science advisory board meetings took place in September 2010. The first meeting comprised the NRRI Environmental Study of Airborne Particulate science advisory board, and the second meeting included the NRRI and School of Public Health external science advisory boards. Age dating of lake sediment continued, as did laboratory analysis of particulates utilizing transmission electron microscopy, scanning electron microscopy, proton-induced x-ray emission, energy dispersive spectrometry, and electron back scatter diffraction.

Current Activity

From January–June 2011, six community sampling events were completed on the roof of the Mechanical Engineering Building at the University of Minnesota in Minneapolis, which completed the field sampling component of this study. During these events, gravimetric data, weather data and particulate samples were obtained. Laboratory analysis of particulates continued, utilizing transmission electron microscopy, scanning electron microscopy, energy dispersive spectroscopy, and electron back scatter diffraction, as did analysis of lake sediment samples. Initial report writing was initiated during this time period.

Principal Investigator(s)

George Hudak
Steven Hauck

Project Sponsor(s)	Amount	Account	Active	
PUF Mineral Endowment	200,000	1896-783-1237-00	07/23/2007	06/30/2012
U of M School of Public Health	350,349		07/01/2008	06/30/2012
Total	$550,349			

Start Date: 07/01/2008 **End Date:** 06/30/2011 **Project ID:** 1539

Geological Resources of Ox Tac Ore in the Vicinity of the Canisteo, Hunner, King, Jennison, Buckeye, Jessie 1 and 2, and West Hill Mines: A Continuing Evaluation of Ox Tac Resources in Itasca County

Objective

To: (1) produce a geological resource estimate of the oxidized taconite ore in the area of the Canisteo, Danube, Morrison, Walker, Fletcher, Hunner, King, Jennison, and Buckeye mines (Sections 25, 36, R25W, T56N and Sections 20, 29, 30, 31, R24W, T56N) in Itasca County, and (2) make the data available in a Geographical Information System (GIS) format that can be used by industry, Itasca County, the State of Minnesota, and local towns and townships for use in future land-use planning.

Background

A current Permanent University Trust Fund (PUTF) project is compiling data on the Judd, Sally, Plummer, Holman-Cliffs, Homestead, Diamond, and Arcturus mine areas located northeast of this proposed study area. Approximately 20 to 30 years ago, there was a great deal of activity aimed at determining the occurrence and quantity of oxidized taconite in both Minnesota and Michigan, as well as evaluating alternative schemes for its exploitation. Currently, there is no mining on the western end of the Mesabi Iron Range in Itasca County, but there has been and are many other uses, i.e., boating, water resource management, other construction, that will directly affect the availability of these oxidized ores in the future. These oxidized taconite, or non-magnetic ore reserves, could become economically beneficial in the future with new mineral processing and mining techniques and with lower stripping and blasting costs. The study will provide these data in a GIS format to local, county, and state agencies that are involved with land-use issues and will allow them to become more aware of the mining potential of the area. Thus, it is hoped that these various entities will use the data to make informed land-use decisions for the western Mesabi Iron Range.

Previous Activity

No work was done on this project due to commitments to complete other projects. The final processing and modeling of the data needs to be completed to finish this project.

Current Activity

No work was done on this project due to commitments to complete other projects. Final processing and modeling of the data needs to be completed to finish this project and final report.

Principal Investigator(s)

Steven Hauck

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		60,000	1896-783-1045-00	07/01/2000	06/30/2012
	Total	$60,000			

Start Date: 07/01/2000 **End Date:** 06/30/2011 **Project ID:** 962

Grant Writing and Grant Search for Minnesota Taconite Operations, State and Federal Department of Energy (DOE)

Objective

To provide funding to NRRI/CMRL Director and staff engineers to evaluate State and Federal DOE grant opportunities, and to work with Minnesota taconite operations to write and submit grants for energy projects in taconite.

Background

More and more State and Federal Department of Energy (DOE) grants are appearing that apply directly to the taconite industry. For example, the Federal DOE "Industries of the Future" program requests specific grant projects for the mining industry that apply to taconite mining. On a State level, NRRI/CMRL can now work directly with the Minnesota State Energy Office to submit grant proposals for potential energy reduction projects in various fields of research and development.

Previous Activity

A number of state and federal grant proposals were written and submitted. Grant funding was received from the DOE, U.S. Economic Development Agency (EDA), Legislative-Citizen Commission on Minnesota Resources (LCCMR), Minerals Coordinating Committee (MCC), Initiative for Renewable Energy and the Environment (IREE), and the MN-DNR/Iron Ore Co-Op.

Current Activity

A number of Federal, State, and University grants were written and submitted to gain future research funding. Grant funding was received from U.S. DOE, U.S. EDA, LCCMR, and IREE. A number of new contacts were established in order to submit grants from a collaborative of research organizations and corporate research groups.

Principal Investigator(s)

Andriy Khotkevych
Blair Benner
Dave Englund
David Hendrickson
Eren Caner Orhan
Kyle Bartholomew
Matthew Mlinar
Richard Kiesel

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		156,315	1896-783-1214-00	02/09/2005	06/30/2012
	Total	$156,315			

Start Date: 02/09/2005 **End Date:** 06/30/2012 **Project ID:** 1390

Hydroseparator Modeling

Objective

To develop a mathematical model of hydroseparators, which could be used for simulation, optimization, and control of hydroseparator operating conditions.

Background

The existing hydroseparator model does not take into account the effect of any operating variables. Available plant data indicate that there are large differences in hydroseparator performance from one plant to another. They are not operated at their optimum due to a lack of quantitative information defining their performance. Analysis of plant data led to the development of the current model, which could simulate the effect of variations in feed grade. Although there appears to be a good correlation between upward velocity and separation efficiency, systematic test work is required to establish such a relationship. Recently, the Coleraine Minerals Research Laboratory (CMRL) received Iron Ore Co-Op (IOC) funding to carry out pilot scale hydroseparator tests in plants to demonstrate the benefits of magnetic field application. These tests will produce samples that could generate data needed for hydroseparator modeling. Funding will be used for additional analysis of these samples and for model development.

Previous Activity

We are working with the former PI and JKMRC to expedite liberation results.

Current Activity

JKMRC is still having problems supplying the necessary liberation data. When the data are supplied, we will work with the former PI to finish the report.

Principal Investigator(s)

Blair Benner
Salih Ersayin

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		36,000	1896-783-1201-00	02/09/2005	06/30/2009
	Total	$36,000			

Start Date: 02/09/2005 **End Date:** 06/30/2011 **Project ID:** 1379

Influence of High Intensity Mixing on Green Ball and Fired Pellet Properties

Objective

To investigate the opportunity that exists to use high intensive mixing of binder and concentrate to reduce additive rates and enhance both green and fired pellet quality.

Background

Historically, high intensive mixing has been cost prohibitive for retrofit in existing taconite operations. However, the economic models have changed. Test procedures, results, and optimum operation conditions can now be determined to provide a comparison that will be made, which will allow taconite operations sufficient data to make economic decisions for potential application.

Previous Activity

It was planned that a matrices of tests using a Design of Experiment (DOE) format would be conducted at bench scale and verified at pilot scale (pot grate tests) using a series of commercially available mixers to blend binders with iron ore concentrate. Standardized procedures for batch balling tests would be used to identify mixing benefits associated with green balls. Pot grate tests would be used to produce fired pellets for metallurgical assays. The Coleraine Minerals Research Laboratory (CMRL) has Muller mixers, PK mixers, and Littleford mixers available for test purposes. B&R Engineering out of Hibbing, Minnesota, has also agreed to provide both batch and pilot scale Eirich mixers for testing. Test parameters would include mixing residence time, mixing speed, bentonite quantity, and filter cake moisture for both standard and fluxed pellet concentrates. Potential independent variables included: green ball properties (drops, plasticity, voidage, dry compressions) and pellet properties (tumbles, compression, drops, porosity, reducibility, LTD, swelling and contraction). Bench scale balling tests with mini-pot pellet quality have been completed. Green ball quality with respect to drop number and dry strength has been improved with intensive mixing. Green balls prepared with intensive mixing and reduced bentonite addition were similar in quality to those with higher addition rates and conventional mixing techniques, and they produced higher quality pellets with respect to after tumble and compression in mini-pot pellets.

Current Activity

Pot grate furnace pellets were prepared for further physical quality and metallurgical test comparisons, including contraction tests conducted by Arcelor-Mittal Minorca. Green balls prepared with both typical and high intensive mixing were fired in the pot grate furance. No significant difference in fired pellet metallurgical quality was observed. However, a benefit with regard to physical quality was noted. High intensity mixing also resulted in pellets with a lower contraction value than those with typical mixing. Testwork is complete. Data analysis and a final report are in progress.

Principal Investigator(s)

Richard Kiesel

Project Sponsor(s)		Amount	Account	Active	
MN DNR		57,502	3005-10417-00014198	05/01/2010	06/30/2011
	Total	$57,502			

Start Date: 05/01/2010 **End Date:** 06/30/2011 **Project ID:** 1631

Investigate Ideas for Further Processing of Taconite Coarse Tailings at the Plant Before Haulage and Stockpiling

Objective

NRRI Duluth and Coleraine will work with each taconite facility to assess how and where coarse taconite tailings are produced in the facility`s flow sheet, and to determine if simple physical methods can be used to efficiently, cost-effectively recover one or more gradations from the process stream cost-effectively. Proposed work would include: 1) taconite plant visit and flow sheet evaluation; 2) development of sample collection/recovery strategy; 3) collect sufficient sample for physical, chemical, and mineralogical characterization; 4) suggest possible recovery methods; 5) estimate cost and benefit of implementing recovery methods; 6) summarize results and produce a final report of investigation.

Background

Based on its taconite aggregate investigations to date, the NRRI feels there is an excellent opportunity for generating value-added products on a modest scale at taconite facilities that make use of the full gradation spectrum of taconite coarse tailings. For example, plants that use spiral classifiers to separate fine and coarse tailings are already doing much of what a commercial aggregate washing/screening plant does to recover aggregate products like sealcoat chips, which are a premium-value aggregate product. Depending on the gradation, such products can sell for $15 to $20 per ton, FOB producer. Some specialty friction products, when dried and bagged, can sell for considerably greater amounts, e.g., over $150 per ton.

Previous Activity

The first in-plant visit to a taconite facility was made to ArcelorMittal Minorca in July of 2010, and the coarse tailings line was inspected for potential product recovery points. Priorities on other projects led to postponement of visits to remaining taconite plants until 2011, when representative samples of coarse tailings will also be collected.

Current Activity

NRRI Duluth and Coleraine (CMRL) collected coarse tailings samples from Keewatin Taconite (Keetac), Hibbing Taconite (Hibtac), United Taconite (Utac), and ArcelorMittal Minorca (Minorca). Screen analyses were performed by CMRL. Sub-samples of each screen interval were retained for follow-up mineralogical evaluation; results of that work are pending. Additional supplemental data were provided by each mining operation. Discussions and/or email communications with engineering staffs also took place. A final report is in preparation, and a complete summary of project results will be presented in the next semi-annual report.

Principal Investigator(s)

Lawrence Zanko
Steven Hauck

Project Sponsor(s)	Amount	Account	Active	
MN Department of Natural Resources	22,800	3005-10416-00014439	05/01/2010	06/30/2011
Total	$22,800			

Start Date: 05/01/2010 **End Date:** 06/30/2011 **Project ID:** 1618

Minerals, Ferrous

Modification of the NRRI Pellet Fines Removal System to Provide More Durable Wear Parts to Improve the Physical Availability of the Unit to Minnesota Taconite Operations

Objective

To provide improved wear parts for the NRRI pellet fines removal system (FRS) to allow the belt to be operated at feed rates of 300-350 tons per hour, 24 hrs per day, to remove pellet fines and chips without needing to replace chevron lifter bars on the belt surface for at least 3-month intervals.

Background

An NRRI pellet fines removal system was previously developed at CMRL, which efficiently removed taconite pellet fines and pellet chips without using vibrating screen components. The pilot scale apparatus was scaled up into a full-scale operating unit, which was mounted on a trailer that could be transported to Minnesota taconite operations or blast furnace steel plant operations for full-scale testing. Tests were initially run at a Minnesota taconite operation, and results showed excellent separation of pellet fines and chips from whole pellets. Chevron-shaped rubber lifters fastened to the flat belt surface were key to the separation process. However, they exhibited excessive abrasive wear, requiring replacement after every 25,000 tons of pellet processing. Tests were run on a variety of high wear resistant materials, which showed that chevrons made of AR400 steel gave the least abrasive wear from the pellets. This is a continuation of previous work reported under Project Tracking #1309, PUTF Fines Removal System.

Previous Activity

It was planned that two return belt carrying rollers (drums) on the original FRS unit would be replaced by 2-inch thick wheels to support the belt and not interfere with the new Abrasion Resistant steel (AR400) lifters, which will be installed on the flat 'flexowell' conveyor belt. These new AR400 lifters will be bolted up through the rubber belt to hold them securely using Flexco conveyor belt clips. Once the older rubber chevron lifters have been replaced with the new AR400 steel chevron lifters, taconite pellet fines removal tests will be conducted at a Minnesota taconite operation to prove the wear capability of the new chevron design, to prove the new design of the carrying belt wheels, and to measure the efficiency of pellet fines removal at pellet feed rates of 300-350 tph. Older rubber chevron lifters were replaced with new AR400 lifter plates, which were bolted to the conveyor belt surface. Tests were run at one of the operating Minnesota taconite facilities, with results showing greater than 90% removal of minus 1/4-inch fines from pellet feeds.

Current Activity

NRRI is now working with an international conveyor belt manufacturer located in Minnesota to establish a manufacturing and marketing group responsible for selling the NRRI designed Pellet Fines Removal System to worldwide markets.

Principal Investigator(s)

David Hendrickson
Richard Kiesel

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		27,335	1750-10417-20090-100001	08/25/2010	12/31/2010
	Total	$27,335			

Start Date: 08/25/2010 **End Date:** 12/31/2011 **Project ID:** 1633

Paired Straight Hearth Furnace Simulation

Objective

To design and construct a furnace with electrical heating, capable of achieving 1600 degrees C in each of two separate zones to accommodate a deep bed of pellets (nominal 120 mm height) and produce Direct Reduced Iron (DRI) under conditions prescribed by the American Iron & Steel Institute (AISI).

Background

CMRL will conduct a study for the AISI Paired Straight Hearth (PSH) Furnace Project to evaluate and assess the quality of Direct Reduced Iron (DRI) pellets achieved from deep bed roasting of green agglomerates in a specifically designed furnace to simulate the PSH process. This program is required to understand the heat transfer and kinetic characteristics for metallization in a tall bed for the design and construction of a pilot plant for the potential commercialization of PSH technology. The proposal is submitted in two parts: 1) design and fabrication of the DRI furnace and 2) production and quality assessment of deep bed produced DRI pellets. Objectives of these tests are to produce DRI pellets with characteristics more closely related to the proposed commercial furnace and to evaluate pellet volume and quality as it transitions the bed.

Previous Activity

The furnace design was finalized and was in agreement with AISI and their associated industrial partners for testing the PSH Furnace process. Fabrication steel was obtained, and frame construction began. Furnace controls, refractories and silicon carbide heating elements were purchased, and construction and installation were planned.

Current Activity

The furnace has been constructed according to the design agreed upon. The furnace was installed, and the exhaust and relevent utilites have been properly connected. Refractory curing, hot commissioning and aquisitioning of raw materials is in progress. Green balls will be prepared according to the specification provided by AISI, using magnetite concentrate and a high volatile bituminous coal for subsequent testing.

Principal Investigator(s)

Richard Kiesel

Project Sponsor(s)	Amount	Account	Active	
American Iron and Steel Intstitute	149,390	3010-10417-00019327	11/30/2010	11/29/2011
Total	$149,390			

Start Date: 11/30/2010 **End Date:** 11/29/2011 **Project ID:** 1641

Performance of Taconite Aggregates in Thin Lift HMA

Objective

To develop and evaluate the performance of hot mix asphalt (HMA) mix designs made with taconite fine aggregate (coarse taconite tailings) and recycled materials like asphalt shingles and recycled asphalt pavement (RAP), to compare the physical properties of these mix designs with conventional HMA mixes, and to conduct chemical leachate (metal) testing of both aggregates and final HMA mixes.

Background

This project is funded by the U.S. Department of Transportation (U.S. DOT), Federal Highway Administration (FHWA). Its goal is to develop and evaluate the performance of hot mix asphalt (HMA) mix designs made with taconite fine aggregate (coarse taconite tailings) and recycled materials like asphalt shingles and recycled asphalt pavement (RAP). NRRI will be the lead organization for this project, and will work closely with research partners at the Minnesota Department of Transportation (MnDOT) Office of Materials, and with the University of Minnesota's Department of Civil Engineering (U of M CE). The project will focus on leachate testing of aggregates, mix designs, and low temperature bending and/or fracture tests on both taconite-based and control HMA mix designs.
Proposed research activities will help advance and encourage the beneficial use of recycled/byproduct materials like durable and wear- and skid-resistant taconite aggregates, recycled asphalt pavement (RAP), and asphalt shingles. In combination, the use of each is highly desirable because it promotes resource conservation, safety, and energy-savings.

Previous Activity

A third progress report was submitted to FHWA on December 31, 2010, presenting an overview of 2nd half of 2010 project activities. The project's five major Study Areas have been described in previous updates. Study Areas 1 and 2 have been completed. Study Areas 3, 4, and 5 are still in progress. Work related to Study Area 4 was delayed during this reporting period. Therefore, the NRRI communicated with FHWA on December 1, 2010, and requested a no-cost time extension to the project. FHWA acknowledged the extension request, and initiated the approval paperwork. Mix design work, specimen preparation, and testing by Mn/DOT and U of M CE will follow. Mix design specimens will be provided to NRRI for further leachate testing.

Current Activity

NRRI's activities from January through early June of 2011 were limited in scope, but are now well underway. Leachate from the aggregate types used in the mix designs, as well as other representative aggregates, is being generated and is being submitted for chemical analysis to an external testing laboratory. Mix design specimens (and un-compacted raw mixes) were provided to NRRI by Mn/DOT on June 22, 2011, for further leachate testing, if needed. Six gyratory specimens were produced by Mn/DOT. The gyratory specimens were also provided to the University of Minnesota, Department of Civil Engineering (UM-CE) for strength testing at three temperatures (-12C, -24C and -36C).

Principal Investigator(s)

Lawrence Zanko
Steven Hauck

Project Sponsor(s)	Amount	Account	Active	
PUF Mineral Endowment	20,000	1750-10416-20090-000130	10/22/2009	07/31/2011
USDOT (Prime)	17,402	3002-10416-00014216	09/25/2009	01/31/2012
US DOT Federal Hwy Admin	82,598	3002-10416-00013020	09/25/2009	01/31/2012
Total	$120,000			

Start Date: 09/25/2009 **End Date:** 07/31/2011 **Project ID:** 1579

Minerals, Ferrous

Sinter Mix Permeability Test

Objective

To develop a bed permeability measurement device and test procedure for measurement of bed permeability in granulated beds and sinter mixes.

Background

Bed permeability is critical to efficient sintering in the steel industry. Sinter pot firing can be minimized (# tests) if granulation for optimum permeability can be established using smaller quantities of material, prior to firing pots. If the total number of pots fired is reduced, sinter programs benefit the client with reduced cost to achieve desired goals in their programs.

Previous Activity

Fabrication of piping and container began in late 2010. Unit will be operational in 2011.

Current Activity

Two permeability containers were made and are operational. One is 6" dia x 16" deep, and the other is 3" dia x 8" deep. Both units have been tested and a basic procedure is in place. The advantage of the smaller unit is that it has a shorter test time and less sample is consumed. The larger unit requires 30 lbs of mix, while the small unit requires about 5 lbs of mix. Several test series have been performed. The test appears capable of relating bed permeablity through air flow to binder, and moisture additions, permitting an optimum set of mix conditions to be defined for maximum airflow.

Principal Investigator(s)

Dave Englund

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		39,890	1750-10417-20090-100001	10/27/2010	06/30/2012
	Total	$39,890			

Start Date: 10/27/2010 **End Date:** 06/30/2012 **Project ID:** 1637

Solid Fuel - Oxygen Fired Combustion for Production of Nodular Reduced Iron to Reduce CO2 Emissions and Improve Energy Efficiencies

Objective

To reduce energy intensity and greenhouse gas emissions in a newly designed Linear Hearth Furnace (LHF) for the production of Nodular Reduced Iron (NRI).

Background

Specific objectives of this research are: (1) Establish baseline energy and greenhouse gas (GHG) intensity of the nodular reduced ironmaking process using standard air-fired natural gas burners, (2) Establish energy and GHG intensity of the nodular reduced ironmaking process using oxygen-fired natural gas burners, (3) Measure the energy and GHG intensity of the nodular reduced ironmaking process using oxygen-fired solid fuel burners and a variety of solid fuel types, (4) Determine the feasibility of using thermally processed biomass as a reductant carbon source for advanced ironmaking, and (5) Evaluate the feasibility of using thermally processed biomass as a fuel for oxygen-fired solid fuel burners in the nodular reduced ironmaking process.

Previous Activity

Baseline conditions for all combustion systems, fuels and conditions tested are complete. GHG emissions were recorded during production of quality NRI from the baseline briquette chemistry, with a full furnace of carbonaceous additives to get a true representation for performance. In addition to natural gas, the solid fuel-oxy burner was utilized to characterize GHG emissions while firing several types of coals and biomass derived “bio-coals”.

Current Activity

The use of thermally processed bio-char was successful for production of NRI. However, the configuration of the solid fuel - oxygen burner system in the Coleraine LHF required it to be processed prior to use. Successful use of the fuel was found to be dependent on reducing the moisture content to less than a few percent, and sizing the bio-char to a size of -20 Mesh. Box furnace tests indicated that the fusion behavior using biomass-derived carbon reductant resulted in significantly reducing fusion time over 30%, while reducing sulfur content of NRI to 0.020% - 0.035%. Reducing the stoichiometric ratio to 75% resulted in decreasing the amount of micro NRI. Blends of bio-char with medium- and high-volatile bituminous coal at 10%, 30% and 50% were conducted with significant results, reducing residence time and sulfur content. Verification of these results in the oxy-fuel fired LHF is in progress.

Principal Investigator(s)

Donald Fosnacht
Richard Kiesel

Project Sponsor(s)	Amount	Account	Active	
US Dept of Energy (USDOE)	299,919	3002-10417-00012454	08/16/2010	08/15/2011
PUF Mineral Endowment	39,249	1750-10417-20090-000124	08/16/2010	08/15/2011
PUF Mineral Endowment	282,434	1750-10417-20090-100001	05/03/2011	06/30/2012
Total	$621,602			

Start Date: 08/16/2010 **End Date:** 08/15/2011 **Project ID:** 1635

Straight Grate Model

Objective

To model a straight-grate iron-oxide induration furnace using material and energy balances involving kinetics for drying, calcinations, and oxidation, and computational fluid dynamics (CFD) for fluid flow and heat transfer.

Background

This project will help pellet plants that operate straight grate furnaces to better understand the material and energy balances around their pelletizing machines, and to explore opportunities for increasing productivity and energy efficiency. The CFD study will provide better understanding of the performance of the recuperation system, energy input, duct design and configuration. A three-dimensional(3-D) CFD model will give more precision in our understanding of the effects of furnace geometries on heat and mass transfer, burner placement, bed depth, and feed conditions. NRRI tasks will include completion of a straight grate Computational Fluid Dynamics model, integrated with a two-dimensional mathematical model under development by Richard Davis.

Previous Activity

In 2008/9 the furnace grid was developed and taken through a preliminary test phase. This model did not have a pellet drying sub-model. The pellet drying model was to be modeled during the project continuation. No work was performed in 2010. Work is continuing in 2011.

Current Activity

The model underwent significant revision, including improved user code for prediction of water evaporation, flux calcination, and magnetite oxidation. The model is considerably more robust. Time constraints allowed only three simulations to be completed. Data analysis and a report are in progress.

Principal Investigator(s)

Dave Englund
Richard Davis

Project Sponsor(s)	Amount	Account	Active	
MN Department of Natural Resources	20,000	3005-10347-00014192	05/01/2010	06/30/2011
Total	$20,000			

Start Date: 05/01/2010 **End Date:** 06/30/2011 **Project ID:** 1639

Systematic Survey & Characterization of Amphibole

Objective

The objective of this project is to physically, mineralogically, and chemically characterize amphibole and phyllosilicate minerals that may become airborne particulates during processing of potential Duluth Complex ores and associated waste rocks. This will be accomplished by scientific evaluations utilizing a wide variety of techniques including petrography, scanning electron microscopy, and transmission electron microscopy.

Background

Ongoing and potential future activities involving mining Duluth Complex ore and associated waste rocks requires a need to identify and characterize elongate particles of silicate minerals that may become airborne as fine particulates. Exposure to elongate mineral particles of phyllosilicate and inosilicates (in particular, asbestiform amphiboles) have been historically linked to lung disease. Late stage deuteric alteration of the mafic minerals (for example, pyroxene and olivine) of the Duluth Complex has produced hydrous secondary amphibole and phyllosilicate minerals in the rock. At the present time, the detailed mineralogy, mineral chemistry, and mineral morphologies of these minerals are not well defined.

Previous Activity

Between July and December 2010, ten diamond drill holes were sampled at the Minnesota Department of Natural Resources core repository in Hibbing, Minnesota. A total of 52 core samples were collected. These samples represent core in the vicinities of the Mesaba, Serpentine, Wetlegs, Longnose, and Waterhen deposits. All 52 samples were subsequently processed to make standard (22 mm by 40 mm) polished thin sections. Preliminary petrographic analysis was conducted on the samples.

Current Activity

Between January and July 2011, ten polished thin sections were shipped to Actlabs in Toronto, Ontario, for mineral liberation analysis (MLA). An additional 5 samples from an eleventh diamond drill hole were located from the Birch Lake deposit to be included in the study. The remaining 42 polished thin sections and the additional 5 samples from Birch Lake were also sent to Actlabs for MLA analysis in June. A total of 17 core samples, at least one sample from each drill hole, were also sent in June to EMS Laboratories, Inc., in Pasadena, California, for elutriation analysis. Additional petrographic tests were conducted on the samples prior to shipping for laboratory analyses. Reporting will follow soon after analytical results are received.

Principal Investigator(s)

George Hudak
Mark Severson
Stephen Monson Geerts
Steven Hauck

Project Sponsor(s)	Amount	Account	Active	
MN Department of Natural Resources	102,000	3005-10416-00014315	02/19/2010	06/30/2011
Total	$102,000			

Start Date: 02/19/2010 **End Date:** 06/30/2011 **Project ID:** 1613

Taconite Industry Products and By-products: An Investigation of Alternative Uses and Their Economic Potential

Objective

To investigate and identify alternative uses for taconite mining products and by-products from each Mesabi Range taconite operation, which have the best potential for providing the greatest short- and long-term economic benefit to the industry. These products and by-products can include gross physical features such as pits, stockpiles, and tailings basins; mined materials such as crude taconite, waste rock, and overburden; and processed materials including crushed taconite, tailings, taconite concentrate, and pellets. The project will attempt to quantify the potential economic impact of the various alternative uses and assign real dollar and cents values to each. The challenge will be to find opportunities that could have meaningful positive economic impacts, given the scale at which the industry operates. Therefore, the project`s focus will be on finding alternatives that have the best income-generating potential, such as those that: (1) demand large volumes/tonnages of lower value materials, (2) have a significant value-added component, or (3) command a steady stream of revenue via property or equipment rental or lease arrangements.

Background

Minnesota's taconite industry is experiencing difficulties that are negatively impacting the region and the entire state. While everyone's main focus should be on helping the industry remain competitive in its primary role, i.e., making iron units from Minnesota ore, it is very important that we try to expand the industry's revenue-generating options by investigating alternative uses and markets for the products and by-products of taconite mining. Even if only one new alternative use or market were identified, it could benefit the entire taconite industry.

Previous Activity

Because this project is closely related to NRRI's ongoing taconite aggregate research efforts, it has provided additional resources that were used for pursuing alternative value-added use options such as various size fractions of taconite tailings; potential as a raw material source for cement making; and communicating related research findings to others. It was planned that a summary report would be filed in the second half of 2010, coincidental with finalization of NRRI's other taconite by-product and co-product activities.

Current Activity

This project was absorbed into the larger EDA Taconite Aggregate program, and a final report on that research was completed in December 2010.

Principal Investigator(s)

Julie Oreskovich
Lawrence Zanko
Steven Hauck

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		65,000	1896-783-1065-00	05/01/2002	06/30/2010
	Total	$65,000			

Start Date: 02/01/2002 **End Date:** 06/30/2011 **Project ID:** 1186

Up-Grade CFD Cooler Models for Grate-Kiln Systems, and Perform Cooler Evaluation of Cooler Speed/Bed Depth on Process Energy Recovery

Objective

To up-grade cooler model grids to Solid Works 3D model versions, because original grids exist in an electronic format that can no longer be modified if future studies require evaluation of physical changes to cooler. This project will also involve performing an evaluation of cooler speed and bed depth effects on process stream temperatures and energy recovery.

Background

The grate-kiln plants were designed around fixed bed depths, which translate into constant speed operation. In time, plant operators pushed production rates to the point where the coolers often become the rate-limiting step in the process. The development of Computational Fluid Dynamic (CFD) models makes it possible to easily simulate cooler performance under a variety of operating conditions. It would be of interest to evaluate cooler performance under conditions of varied bed depth to determine the best depth for optimum heat recovery and pellet discharge temperature. Because each operating line is unique in productivity and ductwork layout, the studies are dependent on the operating line. It is necessary in most cases to perform this evaluation for each line of interest. Additional information with regard to maximum bed temperatures achieved, effect of magnetite oxidation, and oxygen concentration in air streams entering the kiln, will also be evaluated.

Previous Activity

A related earlier project was successful in starting a collaborative effort between the NRRI Coleraine Minerals Research Lab (CMRL) and the Itasca Community College (ICC) Engineering Program. One of the engineering students was hired as a 2009 summer intern at CMRL and conducted work to build models during July/August. The Iron Ore Co-Op portion of this project ended on June 30, 2009. A continuation of the project received high ranking and was awaiting budget approval.

Current Activity

This project was not completed and the contract expired. No new work was performed. There will be no report.

Principal Investigator(s)

Dave Englund

Project Sponsor(s)	Amount	Account	Active	
MN Department of Natural Resources	34,984	3005-10417-00014193	05/01/2010	06/30/2011
Total	$34,984			

Start Date: 05/01/2010 **End Date:** 06/30/2011 **Project ID:** 1583

Upgrading Iron from Lean Ore Stockpiles and Tailings Basins on the Mesabi Iron Range and Producing Value-Added Iron Products

Objective

To evaluate the low-grade stockpiled hematite ore and hematite tailings available from past mining operations on the Mesabi Iron Range, and to ascertain the ability to upgrade the iron in the ore and tailings for production of value-added iron products from these materials.

Background

Millions of tons of hematite low-grade ore stockpiles and coarse tailing material containing 35-40% iron are available from iron ore plants that operated in past decades on the Mesabi Iron Range. Since these ores and tailings are already crushed and ground to a size which can be used directly in mineral processing concentrator flowsheets, operating costs are minimal to turn these low-grade materials into value-added hematite concentrates containing 65-66% iron and 4-5% silica. Flowsheets need to be developed to attract corporate operators to build low-cost concentrating facilities in northeastern Minnesota to recover these valuable iron resources.

Previous Activity

This is a new project.

Current Activity

Various low temperature high intensity magnetic separation and high temperature gas reduction techniques are being tested to provide hematite iron upgrading as applied to stockpiled oxidized taconite and hematite resources in northeastern Minnesota. Gas reduction techniques have shown complete conversion of non-magnetic hematite ores to magnetite ores capable of being upgraded using conventional magnetic technologies currently used in Minnesota taconite operations. Full processing flow sheets have been developed to accomplish this conversion of Minnesota Iron Range stockpiled hematite resources to value added ore capable of being converted for high value taconite pellet production.

Principal Investigator(s)

Blair Benner
David Hendrickson
Richard Kiesel

Project Sponsor(s)		Amount	Account	Active	
PUTF Endowment		125,000	1750-10417-20090-100001	02/19/2011	06/30/2012
	Total	$125,000			

Start Date: 02/19/2011 **End Date:** 06/30/2012 **Project ID:** 1638

Utility of Taconite Materials as Road Patch for Highway Construction

Objective

To confirm the utility of using inorganically bound taconite aggregate and concentrate as highway road patching and construction materials.

Background

Preliminary test work using a proprietary binder formulation has demonstrated the utility of using taconite mining products as a highway patching material. Actual field demonstrations show that the material, if properly formulated, can act as a semi-permanent patch.

Previous Activity

An optimized water-based formulation was developed and demonstrated in late summer and fall of 2010. In October, our private sector licensee convened a focus group meeting at NRRI, during which a field demonstration of both the inorganic and water-based formulations was conducted. Focus group attendees included city, county, state, and private sector public works, highway engineer, and maintenance professionals. Based on the focus group's feedback, a decision was made to scale-up production of the water-based formulation. Before year's end, NRRI prepared two 1,000 lb batches for follow-up field trials. On November 4, the licensee and Mn/DOT performed a successful bridge deck repair near Keewatin, MN, on US Hwy 169. The condition of the repair will be monitored. Other trials are anticipated in early 2011.

Current Activity

A trial repair was conducted by the licensee in early 2011 on Interstate 35E north of downtown St. Paul. Follow-up monitoring of the installation was performed by Mn/DOT. During the remainder of the semi-annual reporting period, NRRI and the licensee focused on making adjustments to the formulation to optimize mix times and performance, in anticipation of preparing large pallet-load sized batches for use in larger-scale field trials during the remainder of 2011.

Principal Investigator(s)

Donald Fosnacht
Lawrence Zanko
Steven Hauck

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		50,000	1896-783-1216-00	02/09/2005	06/30/2012
Minnesota Power		10,000	1831-187-2680-00	02/08/2005	06/30/2012
	Total	$60,000			

Start Date: 02/09/2005 **End Date:** 06/30/2011 **Project ID:** 1392

Minerals, Industrial

Comparative Performance Study of Chip Seal & Bonded Wear Course Systems Applied to Bridge Decks and Approaches

Objective

To provide a comparative evaluation of the performance of several polymeric chip seal (PCS) and ultra-thin bonded wear courses (UTBWC) applied to bridge decks, including sealing and corrosion protection attributes afforded to the deck, as well as improved safety due to increased friction and retention of deicing chemicals as provided by the overlayer. Yearly reports and a final report summarizing this comparative evaluation will be the products of this work.

Background

Recent development and commercialization of various polymeric chip seal and ultra-thin bonded wear courses poses several key questions with respect to the widespread application of these to bridge deck surfaces. Choices must be made among those available in the absence of data allowing for sound comparative assessment. Primary concerns focus on the following performance characteristics: 1) Materials quality and performance quality of materials in a given system, including both the sealing material (e.g. polymer in a PCS system) and the aggregate component; 2) Skid resistance afforded by the overlay system, evaluated by friction measurement over the first few years of service life; 3) Improved safety provided by higher friction as manifested in accident reduction at the application sites; 4) Effectiveness of the sealing component to reduce or eliminate chloride ingress into the deck as a consequence of the use of deicing chemicals; 5) Examination of issues relating to moisture trapping at the seal coat/concrete interface which may cause premature degradation of the concrete, and; 6) Cost/Benefit considerations as related to the above.

Previous Activity

A fully-executed project contract was finalized in July of 2010. NRRI's primary project role is to collect and/or obtain a sufficient and representative amount (and type) of friction aggregate used for each surfacing application at each site. Samples will undergo a standard battery of aggregate quality tests, as well as chemical, mineralogical, and microscopic characterization. Initial samples of bridge deck aggregate materials have been obtained. Additional samples will be obtained in 2011.

Current Activity

A limited amount of work was performed on the project during this period. Various reference articles were also compiled. In the spring of 2011, NRRI prepared and shipped a sample of taconite friction material to the National Center for Asphalt Technology (NCAT) for comparative friction testing; testing results are pending. Similar testing work is planned for the second half of 2011, as well as physical, mineralogical, and chemical testing.

Principal Investigator(s)

Lawrence Zanko

Steven Hauck

Project Sponsor(s)	Amount	Account	Active	
MN Department of Transportation	31,790	3005-10416-00019984	07/08/2010	08/31/2014
Total	$31,790			

Start Date: 07/08/2010 **End Date:** 08/31/2011 **Project ID:** 1616

Minerals, Industrial

Taconite Enhanced Pothole Repair Using Portable Microwave Technology

Objective

To conduct laboratory testing on the most promising combinations of recycled asphalt pavement (RAP), taconite materials, and recycled asphalt shingles (RAS), and conduct cold-weather (mid-winter) field testing at NRRI and at select locations in Anoka and St. Louis counties, using a mobile microwave unit. The field testing work will be done using mobile microwave equipment provided by Microwave Utilities, Inc., (MUI) of Monticello, MN.

Background

Cold-weather (winter to early spring) pothole repairs that use conventional "cold-patch" or "throw-and-go" mixes and methods can be unreliable and prone to early failure. A more effective and longer-lasting repair option is needed by public works and transportation maintenance departments, especially in the late winter, as previous repairs and pavement starts to pop out of the road. Previous joint research activities by NRRI and Dr. David Hopstock suggested that microwave-absorbing taconite aggregate materials, when combined with portable microwave technology, could be an effective solution to cold-weather pothole repair. Subsequent interaction and discussions with representatives of Microwave Utilities, Inc., of Monticello, MN, showed that their company had the technical capability and mobile equipment required to pursue field-testing of the concept of microwave-based pothole repair. A Local Operational Research Assistance (OPERA) Program grant was applied for to conduct field testing of the concept.

Previous Activity

In November of 2010, arrangements were made with St. Louis County to acquire about 3 to 4 tons of -3/4" RAP from a local stockpile. On December 3, 2010, three super sacks were filled and brought back to NRRI. A sieve analysis was run to confirm the size distribution.

Current Activity

The project is complete. A final report was submitted to the OPERA program on May 31, 2011. Testing showed that high-quality repair of potholes can be accomplished safely in all seasons using mobile microwave technology. Importantly, the testing also showed that a combination of -3/4 inch RAP/asphalt millings, -1/4 inch magnetite-containing taconite materials, and recycled asphalt shingles (RAP + Tac + RAS) makes an excellent repair compound. The taconite materials are critical in that they enhance the microwave absorbing properties of the compound, making for a faster and higher-temperature repair. By the project's last test in Anoka, MN, high-quality microwave-based pothole repairs were being completed in about 10 to 12 minutes. While slower than typical "throw-and-go" methods, the permanence of a microwave-based repair should be considered against the cost of sending crews out to repair the same pothole multiple times, as well as the traffic delays associated with repeat repairs. Faster repairs could be accomplished with higher-powered, e.g., up to 100kW, microwave equipment. It is recommended that further demonstration and implementation of this repair technology be conducted and pursued on an expanded basis.

Principal Investigator(s)

Lawrence Zanko
Steven Hauck

Project Sponsor(s)		Amount	Account	Active	
Anoka County		10,000	3003-10416-00018783	06/01/2010	05/31/2011
	Total	$10,000			

Start Date: 06/01/2010 **End Date:** 05/31/2011 **Project ID:** 1609

Copper-Nickel-PGE Mineralization Potential of the Cloquet Lake Intrusion in Northeast Minnesota

Objective

To conduct a first pass reconnaissance sampling campaign to evaluate the potential of the Cloquet Lake Intrusion to host basal Cu-Ni-PGE deposits and/or stratiform PGE reef deposits related to a sulfide saturation event.

Background

The Cloquet Lake Intrusion, comprising part of the Beaver Bay Complex, represents one of the largest Keweenawan-age intrusions in northeast Minnesota. The intrusion is 2-3 times larger than either the Partridge River or South Kawishiwi intrusions, which contain several Cu-Ni-PGE deposits. However, exploration for base and precious metals in the Cloquet Lake Intrusion has been limited to three drill holes. All three holes intersected massive sulfide at the basal contact, but PGE, Cu, and Ni values were generally low, and further exploration efforts were discontinued. Despite this lack of encouraging results, the Cloquet Lake Intrusion should still be explored for the following reasons: (1) the intrusion is situated near a buried crustal ridge of older country rock that may have served as a local sulfur source for basal disseminated Cu-Ni-PGE sulfide deposits; (2) the massive sulfide in the 3 holes may be related to proximity to a vent, wherein, additional massive sulfide with higher Cu-Ni-PGE values (related to fractional crystallization) may be present and could be located more distally to the vent; and (3) the layered nature of this intrusion suggests that it may be possible that one or more stratiform PGE reefs (associated with low sulfide contents) lies hidden in the upper portions of the intrusion. This project would be aimed at collecting more samples of weak to moderately-mineralized rock in order to gain a better appreciation of the mineralized potential of the Cloquet Lake Intrusion.

Previous Activity

Analytical results were received for twenty-eight samples sent in for assay. None of the samples contained any significant values for copper, nickel, and platinum group elements. The thin-section heels were sent in for polished thin-section preparation. Once received, the polished thin-sections will be microscopically scanned to determine the mineralogy (thus the proper rock name), as well as the cumulus and intercumulus phases of the minerals. Once the thin-section study is complete, the final report can be written.

Current Activity

Polished thin sections (28) have been received but have not been described yet due to time constraints.

Principal Investigator(s)

Mark Severson
Steven Hauck

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		15,000	1896-783-1082-00	09/01/2004	06/30/2012
	Total	$15,000			

Start Date: 09/01/2004 **End Date:** 06/30/2011 **Project ID:** 1358

Evaluation of Tailings Generated by CU-NI Ore Processing

Objective

To provide baseline data by characterizing Duluth Complex Cu-Ni ore tailings and assessing their potential for additional mineral recovery and/or value-added beneficial uses on or beyond the mine-site. Following a battery of physical, chemical, and mineralogical tests, potential end-use options will be identified and prioritized for further bench- and/or pilot scale testing and evaluation. The short-term goals are to thoroughly characterize the tailings, determine the viability of extracting additional value from them, e.g., oxide fraction, and identify realistic end uses. The long-term goals are to provide the emerging non-ferrous mining industry and/or entrepreneurs with practical alternatives that are environmentally sound to pursue, technologically simple to implement, and economically beneficial to practice.

Background

Cu-Ni ores from the Duluth Complex will generate more than 30 tons of tailings for every ton of bulk sulfide concentrate produced. This project will provide baseline data by characterizing Duluth Complex Cu-Ni ore tailings and assessing their potential for additional mineral recovery and/or value-added beneficial uses on or beyond the mine-site. Following a battery of physical, chemical, and mineralogical tests, potential end-use options will be identified and prioritized for further bench- and/or pilot scale testing and evaluation. The short-term goals are to thoroughly characterize the tailings, determine the viability of extracting additional value from them, e.g., the oxide fraction, and identify realistic end uses. The long-term goals are to provide the emerging non-ferrous mining industry and/or entrepreneurs with practical alternatives that are environmentally sound to pursue, technologically simple to implement, and economically beneficial to practice. The short-term and long-term benefits to the State of Minnesota include reducing tailings disposal impacts, maximizing resource use, and generating additional revenue streams.

Previous Activity

A planning meeting was held in Coleraine, and samples of tailings were provided to NRRI for preparation and initial characterization. Due to competing priorities on other projects, further project work will be delayed until 2011.

Current Activity

Samples were subjected to wet hi-intensity magnetic separation (WHIMS) at various field strengths, and chemical analyses were performed. Pulps were submitted for mineralogical analyses (XRD and SEM); results are pending. A final report will be completed in the second half of 2011, and a summary of project results will be included in the next semi-annual report.

Principal Investigator(s)

Blair Benner
Lawrence Zanko
Steven Hauck

Project Sponsor(s)	Amount	Account	Active	
MN Department of Natural Resources	15,000	3005-10416-00014395	07/08/2010	06/30/2011
PUF Mineral Endowment	15,000	1750-10416-20090-100000	09/25/2009	06/30/2012
Total	$30,000			

Start Date: 09/25/2009 **End Date:** 06/30/2011 **Project ID:** 1577

Further Evaluation of Diamond Base Metal and Precious Mineral Potential of Minnesota Using Various Glacial Till Sampling and Analytical Methods

Objective

To: (1) compile all pertinent Minnesota geological and geophysical information that are relevant to the formation of diamond pipes; (2) conduct additional processing and mineral analyses on some of the 120 previously collected glacial till samples from the Vermilion District for mineral potential; and (3) conduct a down-ice glacial till demonstration study in the International Falls area using the methods of Larson and other recognized glacial till sampling methodologies for identifying kimberlite and base and precious mineral indicator minerals.

Background

In Canada, sampling glacial till has been successfully used to locate diamond pipes and base metal mineralization. Very limited similar surveys have been conducted in Minnesota, but there has not been a systematic glacial till sampling survey conducted in northern Minnesota.

Previous Activity

Gold data from a new DNR Lands & Minerals survey have been added to the database and gold map and will be incorporated into the final report.

Current Activity

Work is progressing on the final report. To date, the data indicate a large diffuse train of total gold grains strongest in northern and central Minnesota, decreasing to the south. When viewed in conjunction with the pristine and modified gold data, both of which are associated with materials closer to the origin of the gold, we see a more defined pattern in north-central and east-central Minnesota. Silver has a pattern similar to the total gold grains, which makes it difficult to use these indicators for locating source areas. Both pristine and modified gold grains seem to be more useful for that purpose. The 63-micron fraction geochemistry has a number of anomalies, which are associated with known mineral ccurrences. Copper, nickel, palladium, and, to a lesser extent cobalt, chromium and gallium, anomalies are associated with areas of known Volcanogenic Massive Sulfide (VMS) and Duluth Complex mineralization. Zinc shows a stronger affinity for the VMS terranes, while titanium is more closely associated with the Duluth Complex. There is a moderate manganese anomaly associated with the manganese occurrences in the Emily District of the Cuyuna Range.

Principal Investigator(s)

John Heine
Steven Hauck

Project Sponsor(s)	Amount	Account	Active	
MN Department of Natural Resources	74,700	1663-187-6586-00	08/10/2006	06/30/2008
PUF Mineral Endowment	95,000	1896-783-1223-00	07/16/2006	06/30/2010
Total	$169,700			

Start Date: 08/10/2006 **End Date:** 06/30/2011 **Project ID:** 1438

Heavy Stream Discharge from the Falcon Concentrator

Objective

To test various modifications designed to enable a free flow of the heavy mineral stream out of the standard Falcon concentrator bowl. If successful, a performance evaluation will measure the device's ability to separate low silica magnetite out of a mixed stream that contains middlings and gangue.

Background

Previously, the Coleraine Minerals Research Laboratory completed evaluation of the Falcon concentrator, which is a device that separates minerals based on specific gravity. While performance was promising, the previous researcher was concerned regarding clogging of the heavy mineral discharge hardware. Existing magnetic separators are designed to remove magnetite out of the tailings stream, while sending both liberated magnetite and middlings on to further processing, but they don't separate pure magnetite away from the middlings. However, if this can be done with a Falcon, the combination of devices could produce a returning mill feed stream consisting of middlings. As the net mill feed tonnage is reduced, line productivity increases. In addition, if the heavy concentrate is sufficiently low in silica, then flotation recovery will increase. Solving the heavy particle discharge problem with the Falcon concentrator could result in large improvements for taconite

Previous Activity

Tom Larson left the University, and a new principal investigator, Kyle Bartholomew, was assigned to prepare the final report. The centrifuge-type device was recommended for use in a tungsten processing circuit in the Yukon and was run successfully at that location. The unit was also being evaluated for possible copper-nickel upgrading for Minnesota copper-nickel ore. Tom Larson was contacted by Bartholomew, and data were located. Testwork was complete and final report writing was underway. The primary conclusion from the project was that the concentrator shows technical promise for upgrading taconite ore, but the physical configuration of the Falcon concentrator likely makes it too capital intensive for the proposed application.

Current Activity

Test data have been evaluated and a final report is nearly complete. High specific gravity (SG) discharge stream clogging was eilminated by machine redesign. The Falcon increased the SG of each size fraction presented fed. Integration into an existing flowsheet requires addition of a size separation step, since the high SG discharge stream contains liberated, fine magnetite and unliberated coarse particles. Twenty-two percent of feed to the unit reported as high SG, and over 23% of this stream assayed at below 5% silica. Removing fine liberated material from the circulating load in the ball mill circuit increases circuit capacity and reduces overgrinding. Circuit modeling could estimate grinding circuit capacity increases that may be attainable.

Principal Investigator(s)

Kyle Bartholomew
Thomas Larson

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		40,000	1896-783-1208-00	02/09/2005	06/30/2006
	Total	$40,000			

Start Date: 02/09/2005 **End Date:** 06/30/2011 **Project ID:** 1386

History and Compilation of all Gold Exploration Data in Minnesota

Objective

To compile all available information (maps, assays, reports, etc.) from historical records to produce a Guidebook that describes ``who did what, where, and how, and what did they find?`` regarding the gold exploration history of northeastern Minnesota.

Background

Overall, the history of gold exploration in Minnesota may be summarized as very brief periods of activity: Vermilion Gold Rush of 1865-1867, Rainy Lake Gold Rush of 1893-1895, Raspberry Prospect (west of Ely) circa 1900, and more recently, a brief intense campaign in the 1980s following the discovery of the Hemlo gold deposit in Ontario. The latter includes such areas as the Virginia Horn, Lost Lake area in Itasca County, and the Mud Creek Shear Zone/Vermilion Fault area.

Previous Activity

All of the paper and digital records at the Minnesota Department of Natural Resources (MnDNR) have been reviewed and collected for the report. In numerous instances, the digital data are incomplete (especially relative to assay results and drill hole lithologic logs) and the paper copies at the MnDNR were scanned in order to complete the records. In other instances, not all of the pertinent data were turned in to the MnDNR by an exploration company. The next phase of this project will be to contact individuals who worked for some of the exploration companies in an attempt to gain access to the missing data. All of the digital data that are being collected will be included with the final report. Numerous maps showing the locations of drill holes and trenches have been prepared and will also be included with the final report.

Current Activity

Preparation of the final draft has been started, and multiple figures have been made showing the distribution of drill holes and assay results in specific exploration areas. Individuals who actually worked on some of the gold prospects in the 1980s have been contacted for more information. These individuals have sent the author some materials from their personal files and are currently looking for more materials. These materials can be used to fill in gaps in the historical record and will be incorporated in the final report.

Principal Investigator(s)

Mark Severson
Steven Hauck

Project Sponsor(s)	Amount	Account	Active	
MN Department of Natural Resources	31,000	3005-10416-00014540	07/08/2010	06/30/2011
PUF Mineral Endowment	31,000	1750-10416-20090-100000	09/25/2009	06/30/2012
Total	$62,000			

Start Date: 09/25/2009 **End Date:** 06/30/2011 **Project ID:** 1576

Investigation of Various Flotation Reagent Schemes for the Flotation of Sulfides from Minnesota`s Copper-Nickel Deposits

Objective

To determine the best reagent schemes for recovering copper and nickel sulfides from the various Minnesota deposits, to train Coleraine Minerals Research Laboratory (CMRL) technicians in the ``art`` of sulfide flotation, and to develop analytical expertise in copper and nickel.

Background

Much of the sulfide flotation work on Minnesota copper-nickel deposits has been conducted by Lakefield Lab in Canada. Once they have established the "best practice" for one deposit, they appear to apply that practice to all deposits. There are some mineralogical differences between the various deposits, and it may be beneficial to develop different reagent schemes for the different mineralogies. There is a lack of experience at CMRL regarding the flotation of sulfide ores. Running a series of bench scale flotation tests would be a training opportunity. Likewise, the CMRL analysts have little experience in conducting determinations on sulfide samples.

Previous Activity

Several new collectors have arrived from Cytec. They will be tested when the flotation equipment becomes available.

Current Activity

It is anticipated that the current iron ore flotation projects will be completed by mid-September 2011, at which time the sulfide flotation testing will commence.

Principal Investigator(s)

Blair Benner

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		71,144	1750-10417-20090-100000	08/25/2009	06/30/2012
	Total	$71,144			

Start Date: 08/25/2009 **End Date:** 12/30/2012 **Project ID:** 1556

Origin and Distribution of Chromium Mineralization in the Duluth Complex and Related Keweenawan Intrusives in Minnesota, and Its Relationship to PGE Mineralization

Objective

To expand our knowledge of Cr-mineralization and its potential relationship to PGE mineralization by: (1) using existing geochemistry data and collecting Cr-bearing samples for polished thin section analysis; (2) identifying other unassayed drill core that may contain chromium mineralization, analyzing the drill core, and collecting samples for polished thin sections; (3) supporting one Ph.D. thesis on the Birch Lake area that will investigate the PGE-Cr mineralization and relationships to oxide mineralization; (4) conducting quantitative microprobe analyses to determine the various chromium-related minerals; and (5) evaluating and further analysis of one chromium occurrence identified in a drill hole outside of the Duluth Complex.

Background

Chromium (Cr) mineralization associated with PGEs in the Duluth Complex was first recognized by Sabelin and Iwasaki (1985, 1986) in Du-15 in the Birch Lake area. The presence of chromium spinels was noted earlier by Weiblen and Morey (1976) at the Spruce Road deposit. Severson (1995) identified chromium and platinum mineralization in drill hole SL-19 northeast of the Water Hen deposit. Severson (1991) identified Cr-rich spinels in the Local Boy ore zone of the Babbitt deposit. Hauck et al. (in prep.) have identified a variety of Cr-rich spinel in the Birch Lake area, not all of which are directly associated with PGE mineralization. In addition, Heine et al. (1998) reported 1.64% Cr_2O_3 in saprolite in a drill hole drilled into a Keweenawan ultramafic body in Stearns County.

Previous Activity

Several attempts to get samples of the new Ring of Fire chromite deposits have not yet borne fruit, but efforts will continue. Locating chromite and/or Cr-magnetite grains continues as time allows.

Current Activity

A new analytical technique using a Mineral Liberation Analyzer was investigated during the period. The Mineral Liberation Analyzer (MLA) can quickly provide mineral chemistry of all minerals (silicates, carbonates, sulfides, etc.) within a given rock specimen. For this project, polished thin sections of various Cr-bearing and related samples will be sent to a laboratory that operates a MLA. The data to be returned will provide mineral chemistry of all minerals, and a mineral map of the polished thin sections. Data returned will give mineral chemistry of all minerals instead of only selected minerals from a number of polished thin sections.

Principal Investigator(s)

Mark Severson
Steven Hauck

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		76,000	1896-783-1071-00	05/01/2002	06/30/2012
	Total	$76,000			

Start Date: 02/01/2002 **End Date:** 06/30/2011 **Project ID:** 1192

Precambrian Research Center

Objective

To provide training and support to the next generation of geoscientists in modern methods of geological mapping and mapmaking. This training will focus on the unique attributes of mapping the ancient Precambrian rocks of the southern Canadian Shield. The Canadian Shield and similar terranes on every continent are host to many of the world`s premier ore deposits.

Background

The Precambrian Research Center (PRC) was created at the University of Minnesota Duluth (UMD)in 2006 to satisfy an urgent, long-term demand for and critically low supply of geoscientists skilled in field mapping. The PRC seeks to reverse the -decades-long decline in the teaching of geologic mapping skills in U.S. colleges and to provide advanced training to professional geologists.

Previous Activity

FIELD CAMP: Field camp was run from July 4 - August 14, 2010. Twenty-two students from eighteen different colleges from across the United States participated in the field camp. In addition to completing eight field camp exercises, the students completed five capstone maps from various regions comprising Neoarchean and Mesoproterozoic rocks in northeastern Minnesota. WORKSHOPS: The third and most successful professional workshop titled "Geology, Mineralogy, and Genesis of Precambrian Iron Formations" was conducted in October. Sixteen international experts gave lectures, and four field trips were conducted during the course, which was attended by 47 participants. FUNDRAISING: Solicitations were made by email correspondence and the distribution of the annual report. OTHER ACTIVITIES: PRC directors have been organizing the 2011 Minnesota Minerals Education Workshop. Also, PRC directors are on the national committee for organizing field trips for the 2011 Geological Society of America Meeting, which will take place in October 2011 in Minneapolis.

Current Activity

FIELD CAMP: Planning and promotion was conducted for the 5th annual Precambrian field camp to be held July 10-Aug. 20; 22 students from 17 different schools have registered for the camp. WORKSHOPS: A professional workshop typically held in the fall is not scheduled this year because of the national Geological Society of America convention to be held in Minneapolis in October. Hudak and Miller are cochairs of the field trip committee and are leading field trips for the meeting. Miller is also chairing a special topical session on the Midcontinent Rift. STUDENT SUPPORT: One UMD graduate student, Dan Foley, was supported with a PRC graduate research assistantship during the 2010-11 academic year. Dan defended his MS thesis in July. In addition, six students were each awarded $1000 PRC research grants to support their field research on Precambrian geology. FUNDRAISING: PRC welcomed several new corporate members/supporters in the first half of 2011 - Antofagasta, Rio Tinto, Twin Metals Minnesota, and Barr Engineering, as well as continued support from Newmont and Anglo American. We are on track to raise over $100,000 this calendar year.

Principal Investigator(s)

Dean Peterson
Donald Fosnacht
George Hudak
Jim Miller

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		150,000	1896-783-1226-00	07/18/2006	06/30/2010
	Total	$150,000			

Start Date: 07/18/2006 **End Date:** 06/30/2012 **Project ID:** 1432

Reconnaissance Evaluation of the Volcanogenic Massive Sulfide (VMS) Potential in Lake of the Woods, Koochiching & Beltrami Counties

Objective

To determine the volcanogenic massive sulfide potential of an area drilled between the late 1960s and middle 1980s using new ideas about the generation and occurrence of base-metal sulfides.

Background

The main objective of this proposal is to make a first-pass evaluation of the volcanogenic massive sulfide potential, through logging of selected drill holes, within a portion of a greenstone belt (80 mile strike-length) that was drilled by several exploration companies from the late 1960s through the middle 1980s. Many of the holes drilled by the companies intersected massive sulfide horizons associated with a variety of volcanic, chemical, and sedimentary rock packages. However, the massive sulfides in the holes were mainly pyrite and pyrrhotite with limited amounts of base metal sulfides, a fact that discouraged further exploration in the area. At the time, detailed alteration and volcanic facies studies were not routinely conducted by the companies, nor was it recognized that volcanogenic massive sulfide districts typically contain some amounts of base metal-deficient massive sulfides that are distally-located relative to volcanogenic massive sulfide vent areas. In essence, the exploration companies never tried to put together a "big picture" in an attempt to further refine the mineral potential of the area. The goal of this project is to begin to relog the holes, with emphasis on conducting alteration studies and detailed volcanogenic facies mapping (as has been recently done in the Vermilion District by the NRRI and UW-Oshkosh) in order to fully assess and document the mineralization potential of this greenstone belt.

Previous Activity

A review of all of the historical analytical results has been completed and has been entered into an abbreviated drill log listing that will be included as an appendix in the final report. This review indicates that several of the most promising drill holes with massive sulfide intersections are clustered in a thirty-mile long NNE-trending belt. Within this belt, fifteen holes intersected massive sulfide that contain up to 4.9% Zn. One hole in particular (BD-N-1) intersected over 272 feet of massive sulfide, and was terminated in massive sulfide, with a maximum of 0.73% Zn. These data indicate the increased collectivity of this particular belt. Writing of the final report for this project was recently initiated.

Current Activity

The first draft is currently being written. Figures showing the distribution of massive sulfides intersected in drill hole have been prepared. These figures indicate that one belt in particular has the best potential of hosting an economic VMS deposit.

Principal Investigator(s)

Mark Severson
Steven Hauck

Project Sponsor(s)		Amount	Account	Active	
PUF Mineral Endowment		10,000	1896-783-1087-00	09/01/2004	06/30/2012
	Total	$10,000			

Start Date: 09/01/2004 **End Date:** 06/30/2011 **Project ID:** 1356

Peat, Horticultural

Peat Expansion Premier Horticulture, Inc.

Objective

To locate, assess, and secure a suitable horticultural peat resource for Premier Horticulture, Inc., to allow expansion of their Peatrex operation, and to initiate the environmental review and permitting process.

Background

Premier Horticulture, Inc., contacted NRRI for assistance in expanding their Peatrex operation located west of Cromwell, Minnesota. It is estimated that their current peat resource (approximately 240 acres) will be depleted in the next 5 to 10 years. Also, their packaging facilities are presently operating under capacity and could readily handle additional peat from another resource, making the operation more cost-effective and profitable. An expansion would not only maintain present employment at Peatrex, but would also result in 15 additional jobs at the processing plant and harvesting site. Supplementary employment would also occur in spin-off industries such as trucking. NRRI will assist Premier Horticulture, Inc., by: (1) conducting a detailed assessment of potential peat resources in proximity to the Peatrex operation, (2) identifying financial assistance and other incentives available for peatland development from State, County, and local agencies, and (3) assisting in the purchase or lease of the property, and beginning the environmental review and permitting process required by Federal and State regulatory agencies prior to peat development.

Previous Activity

NRRI's involvement in the Wright Bog horticultural peat development remains on hold while Premier negotiates an easement with a local landowner to allow construction of a drainage ditch from the site.

Current Activity

Premier has recently negotiated an easement with a local land owner to allow construction of a drainage ditch from the proposed Wright Bog horticultural peat development. NRRI is anticipated to resume work on the environmental review and permitting process for Premier in the second half of 2011.

Principal Investigator(s)

Kurt Johnson
Steven Hauck

Project Sponsor(s)		Amount	Account	Active	
Minnesota Technology, Inc		99,982	1673-187-6441-00	07/01/1999	06/30/2004
			1196-187-2428-00	10/25/2001	06/30/2012
	Total	$99,982			

Start Date: 07/01/2000 **End Date:** 06/30/2011 **Project ID:** 1074

Peat, Horticultural

Validation of Wetland Mitigation In Abandoned Borrow Areas - Phase II

Objective

To develop cost effective methods for creating functional mitigation wetlands in abandoned borrow areas that meet regulatory permit requirements and are an integral part of road construction projects.

Background

Wetland impacts are often an inevitable consequence of road construction requiring compensatory mitigation. Northeast Minnesota still retains more than 80 percent of its pre-European settlement wetland acreage presenting very few opportunities for traditional mitigation such as wetland restoration. Abandoned borrow areas that have been excavated for road construction materials are one of the few remaining areas that can serve as wetland mitigation sites within the impacted watersheds. In a previous project "Wetland Mitigation in Abandoned Gravel Pits" a demonstration site was established to evaluate techniques for creating fresh meadow, shrub swamp, wooded swamp, and bog wetlands in abandoned gravel pits. Preliminary results are encouraging, but continued monitoring is needed to determine long-term success. This project would continue monitoring for the existing demonstration site wetlands for an additional three years. The effect of established treatments such as donor soil and seed mixes on native plant cover, species richness and diversity will be the primary focus, with special attention to monitoring and control of invasive plant species. Additional vegetation monitoring will also be conducted on other mitigation sites within the U.S. Trunk Highway 53 reconstruction corridor to evaluate their progress. The overall goal of the project is to develop cost effective methods for creating functional mitigation wetlands in abandoned borrow areas that meet regulatory permit requirements.

Previous Activity

In a previous project "Wetland Mitigation in Abandoned Gravel Pits" a demonstration site was established to evaluate techniques for creating fresh meadow, shrub swamp, wooded swamp, and bog wetlands in abandoned gravel pits. Preliminary results are encouraging, but continued monitoring is needed to determine long-term success.

Current Activity

Tasks 1 and 2 were completed in June 2011.

Task 1 was to design a vegetation sampling protocol, water level monitoring well placement, and statistical methods for monitoring 11 additional mitigation sites within the Trunk Highway 53 corridor. A sampling protocol report including vegetation sampling methodology, water level monitoring well placement, statistical methods, and an outline for annual summary reports was completed and approved.

Task 2 was to establish vegetation plots and install water level wells on the 11 additional mitigation sites. A status report including site maps showing established vegetation plot and monitoring well locations was completed and approved.

Principal Investigator(s)

Kurt Johnson
Steven Hauck

Project Sponsor(s)		Amount	Account	Active	
MN DOT		142,023	3005-10415-00022641	03/25/2011	08/31/2014
	Total	$142,023			

Start Date: 03/25/2011 **End Date:** 08/31/2014 **Project ID:** 1628

Peat, Horticultural

Wetland Banking Fens Research Facility

Objective

To restore most of the effectively drained Fens Research Facility (Fens) to a variety of wetland types so new wetland credits can be deposited into a state wetland bank for future withdrawal as wetland mitigation credits.

Background

For about 100 years, the Fens has been used for agriculture, horticulture, fuel peat production, and peatland research. The peat soils have been intensively drained. With recent demand for wetland mitigation credits, the Fens became a candidate for peatland restoration. The Minnesota Board of Water and Soil Resources (BWSR) and the Minnesota Department of Transportation (Mn/DOT) approached NRRI about establishing numerous wetland banks at the Fens. After lengthy review, five banks are in the process of being established. A variety of wetland types are being established. New wetland credits (NWC) are being deposited into BWSR wetland banks. NWC are used for wetland replacement mitigation following loss of wetlands as a result of road construction in Northeast Minnesota.

Previous Activity

In 2002 and 2005, the University of Minnesota (UM) entered into agreements with BWSR and Mn/DOT to restore 333.2 acres of drained peatlands for NWC at the Fens. Under the 2002 and 2005 agreements, the land was cleared, vegetation killed, and the soil rototilled. Subsequently, the ditches were filled, the land leveled and donor material (plant fragments) from nearby bogs was gathered and spread at the Fens. Water wells and vegetation plots were monitored and herbicide was sprayed on invasive species in August and September of each year since bank establishment. In 2008, UM entered into another agreement with BWSR to restore 145.4 acres of drained peatlands for NWC at the Fens. The construction and establishment of monitoring sites followed the same process as that for the 2002 and 2005 agreements.

Current Activity

Limited vegetation and well monitoring of the 2002 and 2005 BWSR and Mn/DOT banks was carried out in the first half of 2011. In late-spring, intensive vegetation and water table monitoring were done on Wetland Banks III, IV and V. In June 2011, BWSR gave approval for the deposit of 15 acres of NWC for Bank IV. BWSR also gave approval for the deposit of 10 acres of NWC for Bank V. Progress was made on obtaining the perpetual conservation easement for Bank V. NRRI continues to meet all agreement requirements for these banks, and NRRI will continue to control invasive species in 2011. The U.S. Army Corps of Engineers (USACE) is nearing approval of the banks established in 2002 and 2005. Wetland Bank IV (2008 agreement) is progressing well as a functioning restored peatland. Preparation was made for upgrading equipment for spraying invasive species.

Principal Investigator(s)

Steven Hauck
Thomas Malterer

Project Sponsor(s)	Amount	Account	Active	
		1196-187-2426-00	05/01/2001	06/30/2012
Total	$			

Start Date: 07/01/2002 **End Date:** 09/30/2013 **Project ID:** 1367

Development Of Peat-Based Media For Waste Water Treatment

Objective

To develop environmentally beneficial peat-based products that can replace chemical treatments for agricultural and remediation purposes.

Background

Peat is partially decayed vegetation that accumulates in wetland bogs. Approximately 15% of Minnesota is covered with this valuable resource. Peat has been investigated by several researchers as a sorbent for the capture of dissolved metals from waste streams. Utilization of peat and other biomass materials for treatment of waste water containing heavy metals is gaining more attention as a simple, effective and economical means of pollution remediation. Besides being plentiful and inexpensive, peat possesses several characteristics that make it an effective media for the removal of dissolved metal pollutants. Drawbacks of using peat are its low mechanical strength, high affinity for water, poor chemical stability, tendency to shrink and/or swell, and leaching of organic compounds. American Peat Technology, LLC, partnered with the Natural Resources Research Institute to develop environmentally beneficial peat-based products that can be used for purification of agricultural and industrial waste water. Developed peat products should overcome the major drawbacks of parent peat material, and should also either inherit parent peat properties to absorb heavy metals or else have additional chemical and physical properties that will be useful for agricultural and remediation purposes.

Previous Activity

The team was able to find a way to overcome the parent material contamination with manganese, and to develop a laboratory-scale procedure for production of newly modified peat granules. It was also found that manganese was present in two forms in the parent peat material.

Current Activity

The team was able to scale up a laboratory procedure for production of newly modified peat granules. Industrial trials were successful in manufacturing a newly developed peat granule on a 500 lb (227 kg) scale.

Principal Investigator(s)

Igor Kolomitsyn

Project Sponsor(s)		Amount	Account	Active	
American Peat Technology, LLC		93,008	3000-10419-00009400	11/13/2009	12/31/2011
	Total	$93,008			

Start Date: 11/13/2009 **End Date:** 12/31/2011 **Project ID:** 1614

Center for Applied Research and Technology – Program Notes
Forestry/Forest Products

Personnel
The Forest Products group hired UMD MBA student Miss Wen Chen as a graduate research assistant. Wen will be responsible for assisting the program in developing a robust program marketing initiative.

Scientific Meetings/Presentations
Matt Aro was invited to give a presentation entitled, "Energy-Efficient and Green Fire-Rated Components for the Manufacture of Doors" at the Window and Door Manufacturers Association 13th Technical Conference held June 20-22, 2011 in Grand Rapids, Michigan.

Bill Berguson gave a presentation of the SunGrant Regional Feedstock's Partnership Poplar Woody Crops Research Program at the Annual SunGrant Contractors Meeting held on February 15-16, 2011 in Knoxville, Tennessee.

Bill Berguson participated as a panel member in the UMD Honors Program Forum on Energy. This was a panel presentation on a variety of energy issues followed by a question-and-answer session for students and the public.

Donald Fosnacht gave a presentation entitled, "Development of Advanced Iron Ore Metallization Technology at the Coleraine Minerals Research Laboratory" at the SME Minnesota Section Technical Conference & Trade Show "A New Decade in Minnesota Mining" held April 12-13, 2011 in Duluth, Minnesota.

Tim Hagen gave a presentation entitled "Development of Torrefied Wood Microchips as an Energy-Efficient Biofuel For Pellet Stoves and Boilers" at the International Biomass Conference and Expo, May 2-5, 2011 in St. Louis, Missouri.

Brian Brashaw gave a presentation entitled "Forest Products Research and Development Overview" during the National Utilization and Marketing Meeting in June 2011 in Minoqua, Wisconsin.

Brian Brashaw gave a presentation entitled "Thermal Treatment Options for Firewood" in June 2011 for the Minnesota Department of Agriculture.

Brian Brashaw gave a presentation "Inspection Techniques to Assess Minnesota's Timber Bridges" during Minnesota's 2011 Annual Bridge Training held in Rochester, St. Paul, Detroit Lakes, Carlton, Mankato, and Arden Hills, Minnesota.

Brian Brashaw presented Policy/Liaisons/Rallying Political Support at the Heating the Midwest with Renewable Energy Summit held on February 9, 2011 in Carlton, Minnesota.

Publications
Victor Krause. 2011. A confidential report was issued to Northern Contours, Inc. Natural Resources Research Institute Technical Report Number NRRI/TR-2011/02.

Victor Krause. 2011. A confidential report was issued to Biovation LLC. Natural Resources Research Institute Technical Report Number NRRI/TR-2011/03.

Victor Krause. 2011. A confidential report was issued to Northern Contours, Inc. Natural Resources Research Institute Technical Report Number NRRI/TR-2011/14.

Victor Krause. 2011. A confidential report was issued to Van Technologies, Inc. Natural Resources Research Institute Technical Report Number NRRI/TR-2011/21.

Victor Krause. 2011. A confidential report was issued to Biovation LLC. Natural Resources Research Institute Technical Report Number NRRI/TR-2011/24.

Brian Brashaw. 2011. Laser Scanning of Minnesota's Historic Zumbrota Covered Bridge. Natural Resources Research Institute Technical Report Number NRRI/TR-2011/04.

Brian Brashaw. 2011. Use of Laser Scanning Technology to Obtain As-Built Records. Natural Resources Research Institute Technical Report Number NRRI/TR-2011/15.

Brian Brashaw. 2011. Nondestructive Evaluation for Advanced Composites. Natural Resources Research Institute Technical Report Number NRRI/TR-2011/16.

Brian Brashaw, R. Vatalaro, and **S. Anderson**. 2011. Use of Laser Scanning Technology to Obtain As-Built Records of Historic Covered Bridges. Natural Resources Research Institute Technical Report Number NRRI/TR-2011/27.

Brian Brashaw, Shan Gao, Robert Ross, and Xiping Wang. 2011. Use of Nondestructive Testing Technologies to Assess Standing Timber Quality. Natural Resources Research Institute Technical Report Number NRRI/TR-2011/32.

Outreach

Agristrand LLC, Panora, Iowa: NRRI produced several particleboard products in support of AgriStrand's pending purchase of the formed Phenix BioComposites particleboard plant located in Mankato, Minnesota. Several resin and raw material combinations were used to produce and test products.

Attica Millwork, Attica, New York: NRRI conducted testing of three groups of thermally treated flooring materials supplied by Attica Millwork to determine the dimensional stability performance as part of Attica's internal research activities. Specific testing included a measurement of flooring cup/crown, bow/ski, twist, thickness, width and weight assessed as received and after equilibration at high relative humidity and low relative humidity conditions.

Bessemer Plywood, Bessemer, Michigan: NRRI evaluated warp defects that were present in plywood products produced, and offered several potential causes for this problem.

Cirrus Aircraft Corporation, Duluth, Minnesota: NRRI conducted pre-conditioning of samples provided by Cirrus. Cirrus staff then conducted evaluations of the materials in the NRRI flame spread chamber.

Epicurean/Loll Duluth, Minnesota: NRRI continued evaluation of raw materials for Loll by exposure to exterior weathering. NRRI also provided consulting and implementation of lean manufacturing for their production operations and planning for a new production facility for Loll.

Ferche Millwork, Rice, Minnesota: NRRI conducted an evaluation of door jamb components to verify and confirm field failures due to specific coating types.

Fond du Lac Reservation, Cloquet, Minnesota: The NRRI conducted a series of small scale pelleting trials on wood residue materials provided by the Fond du Lac Reservation. The focus of the trials was to preliminarily establish a viable species mix, bracket the densification, grinding and moisture parameters,

and produce sample quantities of pellets. Larger scale pelleting trials are planned in the NRRI Pellet Center.

Intectural Duluth, Duluth, Minnesota: NRRI discussed options for evaluation of raw materials and completed a search for standardized testing applicable to the industry.

John's Welding, Tomah, Wisconsin: NRRI conducted a site visit to John's Welding to tour the facility and understand sensor placement for measurement of temperatures during a firewood treatment process. Options for collecting humidity data including temperature and humidity data loggers or wet bulb temperature readings as well as methods for construction of a wet bulb system were discussed.

Loon Call Products, Stillwater, Minnesota: Bruce Werre, President, Loon Call Products, contacted NRRI to inquire on the densification and agglomeration techniques for barley straw. Bruce is advancing the concept of treating phosphorus laden water with oat straw as a means to mitigate algae bloom in rivers, lakes, and streams and is searching for viable densification or agglomeration techniques for oat straw. Tim Hagen and Brian Brashaw explained the variety of densification and agglomeration techniques available at NRRI, its prototyping capabilities, and discussed possible avenues for future cooperation.

Northern Contours, Fergus Falls, Minnesota: NRRI conducted evaluations for physical performance of multiple laminated samples provided by Northern Contours. NRRI evaluated sample cabinet door frames for corner strength before and after exposure to humidity and cold cycles. Adhesive evaluation for membrane pressed doors manufactured in the NRRI membrane press facility was done, testing included pressing variation and heat resistance evaluation.

One at a Time LLC, Floodwood, Minnesota: The company contacted NRRI to inquire on the proper die specification for a 40 HP California Pellet Mill. The company plans to pelletize its residue stream as fuel stock to heat their kiln and provide heat for their buildings. NRRI and AURI provided a die on loan for them to try. Pellet trials will commence at One at a Time LLC in late September 2011.

Sylva Corporation, Princeton, Minnesota: Chris Stephen, Technical Sales Manager, contacted NRRI to inquire on the specifications of BioChar in the marketplace. Sylva is in the process of positioning a BioChar product for the market place and requested any publications or any additional information surrounding the BioChar field. The NRRI provided a BioChar reference document recently published by the USDA and an ultimate and proximate analysis conducted on their BioChar in Feb 2011.

Van Technologies, Duluth, Minnesota: NRRI conducted standardized testing of samples provided by Van Technologies. Standard tests included ASTM D2197 Scrape , ASTM D2794 Impact Resistance, ASTM D4060 Taber Abrasion, ASTM D3459 Humid Dry Cycles, ASTM D3023 Chemical Resistance, ASTM D5402 Acetone Rubs, and KCMA Hot/Cold Check. A report was submitted to Van Technologies following completion of the testing.

Michigan State University, Purdue University, and the University of Illinois: The forestry staff assisted Michigan State University, Purdue University, and the University of Illinois by providing plant material for poplar field trials at various locations in the Midwest.

Potlatch Corporation, Cloquet, Minnesota: The forestry staff met with Potlatch Corporation to discuss options to accelerate production of aspen for a variety of uses. NRRI conducted analysis of aspen stand growth to determine growth patterns in mid-rotation aspen stands and evaluate options for higher utilization of wood in these stands.

Verso Paper Company, Alexandria, Minnesota: The forestry staff assisted Verso Paper Company staff in evaluation of the hybrid poplar genetic improvement program and selection of clones for commercial application in central Minnesota.

Facilities

The greenhouse at NRRI is being used currently to produce seedlings resulting from the 2011 breeding. We anticipate using the greenhouse through August and are beginning preparation for use of the greenhouse for the 2011/2012 breeding in November. The controlled climate facility is being tested at this time to determine the performance of the cooling system under various levels of ambient humidity. The purpose of this testing is to improve performance of the system prior to the 2011/2012 breeding activities.

The Forest Products group purchased a new QUV spray machine to initiate a testing program for accelerated aging of exterior wood products and exterior wood coatings. This equipment will provide key technical support for NRRI clients.

Chemical Extractives

Scientific Meetings/Presentations/Proposals/Awards

Dr. Pavel Krasutsky and Jonathan Lee presented "Development of Biorefinery for Processing DDGS into Biofuels and Other Value Added Products" to the *Minnesota Corn Growers Association* and the *Minnesota Corn Research and Promotion Council* on March 11, 2011, with Professor Douglas Tiffany (UMN); this proposal was awarded a grant of $100,000.

On April 22, 2011, Oksana Kolomitsyna and Dr. Pavel Krasutsky received Inventor Recognition Awards for their achievements in developing intellectual property for the University of Minnesota.

Dr. Pavel A. Krasutsky submitted a proposal to the Institute of Renewable Energy and Environment (IREE) for matching funds for the project "Development of Biorefinery for Processing DDGS into Biofuels and Other Value Added Products." This proposal was awarded $60,000.

The Chemical Extractives Laboratory's efforts on biofuel research and development were reported in Ethanol Producers' magazine Distillers Grains, in the article "Making the Most of DDGS," by Kris Bevill; http://www.ethanolproducer.com/articles/7832/making-the-most-of-ddgs; June 6, 2011, pages 20-23.

Dr. Pavel Krasutsky (NRRI) and Douglas Tiffany (UMN) were members of a panel at the *International Fuel Ethanol Workshop & Expo*, June 27-30, 2011, in Indianapolis, IN, discussing the technical and economic aspects of the project "Development of Biorefinery for Processing DDGS into Biofuels and Other Value Added Products."

The company *Betula Extractive, LLC*, was formed in Minneapolis, MN. This LLC received a temporary license for Intellectual Property (IP) created at the Chemical Extractives Laboratory as related to the technology of manufacturing and uses of birch bark products.

In cooperation with the UMD School of Medicine, the Chemical Extractives Laboratory has been awarded $15,000 based on a proposal to Whiteside Institute entitled "Design of Novel Triterpene-Based Anticancer Chemotherapeutics with a Dual Mechanism of Action."

Coleraine Minerals Research Lab & Economic Geology Group

Scientific Meetings/Presentations/Papers

Jim Miller gave a presentation on January 14 on the subject "Geochemistry of Mafic Layered Intrusions" at the Canadian Institute of Mining workshop, Thunder Bay, Ontario, Canada.

Dave Hendrickson was chairman of the General Session of the 72nd Annual University of Minnesota Mining Symposium, held in conjunction with the 84th Annual Meeting of the Minnesota Section of SME at the Duluth Entertainment and Convention Center (DECC) on April 12th in Duluth, Minnesota.

Blair Benner was chairman of the Processing Session of the 72nd Annual University of Minnesota Mining Symposium held in conjunction with the 84th Annual Meeting of the Minnesota Section of SME on April 12th in Duluth, Minnesota.

Steve Hauck was chairman of the Non-ferrous Session of the 72nd Annual University of Minnesota Mining Symposium held in conjunction with the 84th Annual Meeting of the Minnesota Section of SME on April 12th in Duluth, Minnesota.

Lawrence Zanko and Donald Fosnacht presented "Research, Development, and Marketing of Minnesota's Iron Range Aggregate Materials for Midwest and National Transportation Applications: An Overview

and Presentation of Major Project Findings" at the SME Conference in Duluth, Minnesota, on April 12, 2011.
At the SME Conference at the DECC on April 13, 2011, a presentation was given entitled, "Development of Advanced Iron Ore Metallization Technology at the Coleraine Minerals Research Laboratory." This work was authored by Richard Kiesel, David Englund, Donald Fosnacht, David Hendrickson, Iwao Iwasaki and Rodney Bleifuss.

A paper was presented at the AIST Conference in Indianapolis, Indiana, May 1-3, 2011. The presentation was entitled, "Next-Generation Metallic Iron Nodule Technology for EAF Steelmaking." Authors were Donald Fosnacht, Iwao Iwasaki, Richard Kiesel, David Englund, David Hendrickson and Rodney Bleifuss.

On May 18-20, PreCambrian Research Center (PRC) field camp students presented five posters at the Institute on Lake Superior Geology (ILSG) meeting held in Ashland, Wisconsin.

Jim Miller gave a May 20 oral presentation on the "Petrology of the Ni-Cu-PGE Mineralized Tamarack Intrusion, Aitkin and Carlton Counties, MN" at the ILSG meeting in Ashland, Wisconsin.

Jim Miller gave a presentation on the "Geology and Mineral Deposits of the Duluth Complex" at a June 29 workshop for United States Forest Service (USFS) staff of the Superior National Forest.

Publications
Coleraine Technical Reports
NRRI/TR-2011/05-Confidential Report issued to Midland Research – R. F. Kiesel – January 13, 2011 – 3 pgs.

NRRI/TR-2011/06-Confidential Report issued to Intelgec – B. R. Benner – February 15, 2011 – 29 pgs.

NRRI/TR-2011/07-Confidential Report issued to Airproducts – B. R. Benner – February 15, 2011 – 10 pgs.

NRRI/TR-2011/08-Confidential Report issued to United Taconite – B. R. Benner – February 15, 2011 – 2 pgs.

NRRI/TR-2011/09-Confidential Report issued to Duluth Metals – B. R. Benner – February 15, 2011 – 17 pgs.

NRRI/TR-2011/10-Confidential Report issued to Mesabi Nugget – R. F. Kiesel – December 9, 2010 – 3 pgs.

NRRI/TR-2011/17-Confidential Report issued to Erdemir/Ermaden – B. R. Benner and E. C. Orhan – April 8, 2011 – 243 pgs.

NRRI/TR-2011/26-Confidential Report issued to Uniao Mineracao – B. R. Benner – May 25, 2011 – 17 pgs.

NRRI/TR-2011/30-Confidential Report issued to Clariant – B. R. Benner – June 20, 2011 – 12 pgs.

Economic Geology Group Technical Reports
NRRI/TR-2011/01-Confidential Report issued to Erdemir Maden – S. Hauck – 2011 – 112 pgs.

Miller, J.D., 2011, Trip 1: Igneous stratigraphy of the Layered Series at Duluth - Type Intrusion of the Duluth Complex. In 57th Annual Institute on Lake Superior Geology, Proceedings Volume 57, Part 2 - Field Trip Guidebook, Ashland, Wisconsin, pgs. 1-29.

Economic Geology Group Technical Summary Reports
Zanko, L. M., 2011, Cost Comparison of Underground and Surface Mining Options for Potential Western Mesabi Range Iron Ore Resources: Natural Resources Research Institute, University of Minnesota Duluth, Technical Summary Report NRRI/TSR-2011/01, 4 pgs.

Economic Geology Group Reports of Investigation
Severson, M. J., 2011, Preliminary Evaluation of Establishing an Underground Taconite Mine, to Be Used Later as a Lower Reservoir in a Pumped Hydro Energy Storage Facility, on the Mesabi Iron Range, Minnesota: University of Minnesota Duluth, Natural Resources Research Institute, Report of Investigation NRRI/RI-2011/02, 28 pgs.

Economic Geology Group Posters
Hauck, S., Gosnold, W., Severson, M., and Heine, J., 2011, Remapping Minnesota's Geothermal Heat Flow: University of Minnesota Duluth, Natural Resources Research Institute, NRRI/POSTER-2011/01.

Hudak, G., Monson Geerts, S., and Zanko, L., 2011, Environmental Study of Airborne Particulates in Population Centers on the Mesabi Iron Range - Progress Report April 2011: University of Minnesota Duluth, Natural Resources Research Institute, NRRI/POSTER-2011/02.

Hudak, G., Monson Geerts, S., Zanko, L., Severson, A. K., Severson, A. R., and Bandli, B., 2011, The Minnesota Taconite Workers Health Study: Environmental Study of Airborne Particulates – 2011 Update: University of Minnesota Duluth, Natural Resources Research Institute, NRRI/POSTER-2011/03.

Outreach
Miller, J. gave four lectures on February 11 on the topic "Mineral Resources of Minnesota" at the annual Minnesota Earth Science Teachers Association meeting in St. Cloud.

Miller, J. led a one-day field trip on May 18, teaching the "Geology of the Layered Series at Duluth" for 28 participants as part of the Institute on Lake Superior Geology meeting.

Miller, J. led an all-day "Curiosity Camp" lecture and field trip on June 14 regarding the "Geology of Interstate Park" for 32 participants. Curiosity Camps are sponsored by the U of MN-Twin Cities Compleat Scholar program.

The NRRI Precambrian Research Center (PRC) took the lead role in planning and conducting the 14th annual Minnesota Minerals Education Workshop on June 20-23, which was held at the Mesabi Range Community and Technical College in Eveleth, MN. The 3-day workshop was for 76 K-12 science teachers and involved over 25 volunteers from the NRRI, UMD, Minnesota Geological Survey (MGS), DNR, IRRRB, Cliffs, K-12 institutions, and private individuals. J. Miller served as meeting chair and M. Patelke served as co-chair.

Miller, J. led a field trip on June 27 to Interstate Park for the TIMES (Teaching Inquiry Methods in Earth Science) for 15 middle school teachers.

Abstracts for ILSG meeting (May 18-20, Ashland, WI) by PRC staff and students:
Ryan Birkmeier, Tyler Boley, Brittnee Brannan, Ryan Doucette, Mark Jirsa, and Aubrey Lee - Geologic mapping of Neoarchean rocks near Ogishkemuncie Lake, by students of the Precambrian Research Center's 2010 field camp, pgs. 5-6.

Eric J. Carlson, Terrence J. Boerboom, Corey J. Holton, Kyle W. Kubitza, Lucy Mulvey, and Eric Scheurer - Mesoproterozoic bedrock in the Kadunce River Quadrangle, NE Minnesota—Precambrian Research Center capstone, pgs. 14-15.

Dan Cervin, Penny Morton, Jim Miller, and Richard Patelke - Characterization of precious metal occurrences in the NorthMet deposit of the Partridge River Intrusion, Duluth Complex, Minnesota, USA, pgs. 16-17.

Ryan N. Dayton, James D. Miller, and Jeffery D. Vervoort - The geochemical evolution of the Sonju Lake intrusion: an assimilation-fractional crystallization model, pgs. 26-27.

Daniel J. Foley, and James D. Miller - Petrology and Cu-Ni-PGE mineralization of the Bovine Igneous Complex, Baraga County, Northern Michigan, pgs. 37-38

Brian D. Goldner and James D. Miller - Petrology of the Ni-Cu-PGE-mineralized Tamarack Intrusion, Aitkin and Carlton Counties, Minnesota, pgs. 44-45

Jim Miller, Ben Brooker, Max Hadley, Levi Markwood, Jeff Olson, and Alex Tomlinson - 2010 Precambrian Field Camp Mapping in the Jack Lake Area, Cook County, Northeastern Minnesota, pgs. 61-62.

Amy L. Radakovich, Charlie T. Parent, Molly E. Partridge, Andrew D. Ritts, Rita Pierce, and George J. Hudak - Reconnaissance Bedrock Geological map of the northern part of Sudan Underground Mine State Park and the northwestern part of Lake Vermilion State Park, St. Louis County, Minnesota, pgs. 67-68.

Cabin Ross, George Hudak, Ron Morton, Tom Quigley, and Bob Mahin - Preliminary stratigraphy and physical volcanology associated with the Paleoproterozoic Backforty VMS deposit, Menominee County, Michigan, pgs. 70-71.

Steph Theriault, Jim Miller, Mike Berndt, and Ed Ripley - The mineralogy, spatial distribution, and isotope geochemistry of sulfide minerals in the Biwabik Iron Formation, pgs. 81-82.

Alexandra M. Vallowe, Ernest J. Thalhamer, Damon L. Rhoades, and Dean M. Peterson - Surface and subsurface geologic maps of the Soudan Underground Mine State Park, St. Louis County, Northeastern Minnesota , pgs. 87-88.

Jakob Wartman, Ron Morton, George Hudak, and Cory Hercun - Physical volcanology and hydrothermal alteration of the Rainy River Gold Project, Northwestern Ontario, pgs. 95-96.

Center for Water and the Environment

A Coastal Atlas for Lake Superior`s North Shore

Objective

We propose to create a coastal atlas that consolidates social, economic, and environmental data for townships and municipalities within the MLSCP coastal boundary. The atlas will be a print-copy resource comprising map plates of fundamental data for each individual township or municipality. The atlas will include information relevant to land use permitting, including the distribution of wetlands, bluffs or steep slopes, impervious surface, and streams and lakes. Data for each geographic entity will also include several state-of-the-art data sets, such as a high-resolution watershed delineation (mean size 320 ac; recently funded through the EPA‘s Great Lakes National Program Office), summaries of point sources from the NPDES and Toxic Release Inventory, and a summary of non-point environmental stressors (urban and agricultural land use, road density) by watershed.

Background

Lake Superior's North Shore is becoming increasingly rich in data. There have been numerous concerted data compilation efforts over the past several years, with the ultimate objective of providing data to inform land management decisions. Most of these projects were designed to deliver spatial data as GIS shapefiles, the technical format used to incorporate spatial layers into a geographic information system. The CoastalGIS project, funded by Minnesota‘s Lake Superior‘s Coastal Program from 2001 to 2005, created a repository for hydrologic, administrative, natural resource, and other spatial data sources.

While these data are extremely valuable to local and regional planning efforts, they are distributed across numerous repositories, and often available only in technical GIS formats, which makes them less accessible to local units of government without GIS expertise.

Previous Activity

This is a new project.

Current Activity

We have selected a suite of geospatial data sets to include in the Coastal Atlas. This past quarter we used Esri ArcGIS Map Book tool to create the individual maps for the communities of the Lake Superior Coastal Program boundary. The Map Book tool allows us to incorporate the data into a ArcMap session and build the basic cartographic template, including colors, labeling, scale, legend, titles and sub-titles. Data sets incorporated to date include: streams, lakes, wetlands, high-res watersheds, power lines, land use/cover, transportation infrastructure, state parks, state forests, trails, access points, boat launches, and safe harbors.

We also developed a prototype interactive map display for the CoastalGIS. This allows the viewer to select a community either from a map or a list - then loads a page with links to map PDFs. We are using an interactive form of PDFs created by Map Book; a user can turn layers on and off from the PDF map, giving them the ability to edit the map to fit their needs. We continue to work with Coastal Program staff on developing a list on what Coastal Program funded data would be added to CoastalGIS.

Principal Investigator(s)

George Host

Project Sponsor(s)	Amount	Account	Active	
MN`s Lake Superior Coastal Program	33,759	3013-10424-00014997	08/16/2010	12/31/2011
Total	$33,759			

Start Date: 08/16/2010 **End Date:** 12/31/2011 **Project ID:** 1597

Acceleration of Inorganic Nutrient Release and Mineral Organic Matter Association by Biophysical Soil Mixing along an Earthworm Invasion Chronosequence

Objective

Two major life sustaining processes of the terrestrial earth surface are the release of inorganic nutrients through mineral weathering and carbon cycling, which are strongly influenced by soil organisms. We propose that vertical soil mixing by earthworms will have far reaching impacts on the rates of mineral weathering and carbon cycling when viewed against the steep vertical gradients in: 1) the concentrations, compositions and dynamics of minerals and organic matter, and 2) the geochemical environment affecting mineral weathering that define soil types. Our goal is to understand how and to what degree soil perturbation by earthworms affects the rates of chemical weathering and organic matter-mineral association in soils. Although earthworms are widely perceived to have beneficial influences on soil structure and nutrient dynamics, recent research has shown them to have negative impacts on soil structure, nutrient availability and water dynamics in cold-temperate hardwood forests.

Background

Dr. Hale's research characterized earthworm invasion chronosequences in the Chippewa National Forests that could be used to examine the effects non-native earthworms have on carbon and mineral weathering dynamics in cold-temperate hardwood forests.

Previous Activity

Earthworm sampling was conducted using the mustard extraction technique at 30 plots along three transects along an earthworm invasion chronosequence. Midden counts were also conducted to estimate populations of deep dwelling species.

Soil sampling was conducted in six excavated soil pits with varying degrees of earthworm invasion. Detailed soil morphologic description was made and two sets of samples by horizons were collected for analysis of bulk density, elemental composition, C and N concentrations, stable isotope ratios, mineralogical compositions, and the activities of short-lived isotopes. Another set of samples were collected specifically for 14C analysis.

At each excavated soil pit, three zero tension lysimeters were installed below the A and E1 horizons and at the depth of 45 cm; five piezometers were installed. The lysimeters and piezometers will be allowed to equilibrate with the surrounding environments until the next snow melt when water sampling will begin.

Current Activity

Principal Investigator(s)

Cindy Hale

Project Sponsor(s)		Amount	Account	Active	
Univ of Delaware (USDA Prime)		16,223	3014-10424-00002871	09/01/2008	08/31/2011
	Total	$16,223			

Start Date: 09/01/2008 **End Date:** 08/31/2011 **Project ID:** 1565

Avian Migration within the Lake Superior Coastal Region

Objective

1) Assess the timing, distribution, and relative abundance of fall migrants along the North Shore of Lake Superior, 2) Examine fine-scale stopover habitat selection of migrants, 3) Improve understanding of landscapes of migratory stopover sites, and 4) Provide recommendations for conservation priorities to ensure protection of migratory bird populations along the North Shore of Lake Superior.

Background

Over the past 50 years there has been increasing urban, exurban, and recreational development along the North Shore of Lake Superior, while recently there has been strong interest and plans to develop wind energy along the North Shore ridges. During bird migration periods, the Great Lakes are a migration barrier resulting in vast congregations of birds on or near shorelines, especially on the North Shore of Lake Superior.

Previous Activity

Data have been gathered on the fall bird migration along the North Shore during the fall of 2008 and 2009 with other funding sources. Compiling and analyzing data.

Current Activity

Data error correction is nearing completion for all the data gathered during fall migration in 2008, 2009, and 2010. Preliminary analysis and model development of bird movement data is underway. Preliminary results indicate passerine movements are correlated with date, time of day, and distance from the Lake Superior shoreline. Raptor movements also follow this trend but to a lesser degree. Full data analysis will occur upon completion of data error correction.

Principal Investigator(s)

Anna Peterson
Annie Bracey
Gerald Niemi

Project Sponsor(s)		Amount	Account	Active	
USDI Fish and Wildlife		38,110	3002-10429-00010606	10/01/2009	09/30/2011
	Total	$38,110			

Start Date: 10/01/2009 **End Date:** 12/31/2011 **Project ID:** 1564

Bird Surveys in Agassiz Lowlands Subsection

Objective

Gather information on breeding bird populations in the Agassiz Lowlands section of Minnesota.

Background

This is a short term project primarily focused on the June 2011 breeding season.

Previous Activity

This is a new project.

Current Activity

Breeding bird data were gathered from a series of lowland coniferous sites identified by the Minnesota DNR in Grand Rapids. These sites were in stands of various age classes, cover types (e.g., black spruce, tamarack,and white cedar), and site quality. Counts were all completed by June 30, 2011. A report will be sent to the Minnesota DNR with the results of the surveys. These surveys will form the basis on decisions regarding future work in the Agassiz lowlands subsection, especially in the context of future logging within these vast lowlands.

Principal Investigator(s)

Annie Bracey
Gerald Niemi

Project Sponsor(s)		Amount	Account	Active	
MN DNR		3,000	3005-10429-00024060	05/15/2011	06/30/2011
	Total	$3,000			

Start Date: 05/15/2011 **End Date:** 06/30/2011 **Project ID:** 1645

Development of a Comprehensive Conservation Strategy for the North Shore Highlands Region of Minnesota in the Context of Future Wind Power Development

Objective

To develop a migratory bird comprehensive conservation plan for the North Shore Highlands with recommendations for future wind development. Recommendations will be based on models of migratory bird habitat and flyway characteristics developed from data collected over three fall migration seasons (2008, 2009, and 2010) in the North Shore Highlands region.

Background

There is considerable interest in the development of wind energy in the North Shore Highlands and high potential for negative effects for migrating birds. The North Shore Highlands is the largest migratory route for birds of prey in Minnesota and among the highest in the U.S. Large numbers of other migratory birds have also been counted in the North Shore Highlands, including 22 non-raptors listed as species of greatest conservation need (Common Nighthawk, Golden-winged Warbler, and Rusty Blackbird). We will provide a comprehensive conservation plan for these migratory birds highlighting the potential risks of wind energy development within the North Shore Highlands region.

Previous Activity

Preliminary analysis and model development of bird movement data is underway. Preliminary results indicate passerine movements are correlated with date, time of day, and distance from the Lake Superior shoreline. Niemi has been working with a previous graduate student who gathered data in fall 2008 and they will be submitting a peer-reviewed journal article on the experimental design used to gather these data. This is pertinent and important because we are unaware of any previous studies that have undertaken the sampling of such a large landscape for bird movements. The status of this peer review and comments received in the peer-review process will be beneficial for the ultimate results of this project.

Current Activity

Data error correction is nearing completion. Preliminary analysis and model development of bird movement data is underway. Preliminary results indicate passerine movements are correlated with date, time of day, and distance from the Lake Superior shoreline. Raptor movements also follow this trend but to a lesser degree. Full data analysis will occur upon completion of data error correction.

The Sharp-shinned Hawk telemetry study that was potentially to be started in fall 2010 was delayed until the fall of 2011. This was primarily due to the need to carefully plan out the study and avoid making hasty decisions. We have been consulting with Dr. Laurie Goodrich of Hawk Mountain, Pennsylvania who completed a similar study on Sharp-shinned Hawks in the Appalachians. The rugged landscape of North Shore of Lake Superior will present some challenges in terms of tracking these birds once they are released. This is the primary migratory season for Sharp-shinned Hawks in this area.

Principal Investigator(s)

Annie Bracey
Gerald Niemi

Project Sponsor(s)		Amount	Account	Active	
USDI Fish and Wildlife		38,110	3002-10429-00010606	10/01/2009	09/30/2011
	Total	$38,110			

Start Date: 07/16/2010 **End Date:** 12/31/2011 **Project ID:** 1596

Identifying Critical Habitats for Moose in Northeastern Minnesota

Objective

The project is a coordinated effort to determine if it is possible to slow or prevent a decline in the northeastern Minnesota moose population. Public outreach and education will be accomplished with a website that provides information on moose in Minnesota and allows the public to report moose sightings. The Minnesota Zoo in Apple Valley will develop an on-site informational kiosk about Minnesota moose and zoo educators will help develop a curriculum for teacher workshops to be held both at the zoo and at the Boulder Lake Environmental Learning Center near Duluth. We will schedule 25 public moose presentations per year. The project combines research and education to increase public understanding of Minnesota moose now and in the future.

Background

Moose are one of Minnesota‘s most prized wildlife species. In less than 20 years moose in northwestern Minnesota declined from over 4,000 to fewer than 100. The northeastern Minnesota moose population, with over 7,000 moose, may be beginning a similar decline. Higher mortality in radiocollared moose is correlated with warm temperatures. We will use satellite collars to track moose in northeastern Minnesota and collect GPS locations day and night 365 days a year. Specific habitats needed by moose will be identified using the satellite collars. Spatial distribution and availability of habitat types will guide identification of specific sites for enhancement, protection, or acquisition. Development of habitat guidelines will help private and public land managers provide the best possible habitat for moose.

Previous Activity

This is a new project.

Current Activity

This is one of four GPS collar projects currently ongoing. In January of 2011, we deployed collars on 64 moose that will collect GPS locations every 20 minutes and send the locations via the Iridium satellite cell phone network to the PI. In addition, activity and air temperature is monitored on the collar. This is the first project in the world to take locations frequently enough to monitor an animal‘s movement 24 hours a day, 7 days a week. We expect that it will provide insight into landscape use by moose, management activities that could benefit moose, habitat selection in cool and hot weather, and information on calving by moose.

The Minnesota Zoo completed updating the existing moose display with new graphics that cover basic moose biology, explain historical trends in moose populations in Minnesota, and present findings from this project. A new moose sculpture was acquired by the zoo with other funding.

Principal Investigator(s)

Ronald Moen

Project Sponsor(s)		Amount	Account	Active	
LCMR		507,000	3015-10430-00010577	07/01/2010	06/30/2013
	Total	$507,000			

Start Date: 07/01/2010 **End Date:** 06/30/2013 **Project ID:** 1586

Lake Superior Carnivore Monitoring

Objective

Summarize existing data on carnivore distribution in Lake Superior watershed.

Background

The Lake Superior Binational Program is a partnership of federal, state, provincial, and tribal/First Nation governments working with citizens to ensure the protection of the Lake Superior watershed. Among the needs to meet this goal is improved knowledge of plant and animal species within the watershed. An update on the status of reptiles and amphibians has been completed, also needed is an update on the status of mammalian carnivores in the watershed.

Previous Activity

The deliverable product for the work described below would be a similar report for mammalian carnivores. Content would differ for several reasons, including historical management, cataloging of museum records, availability of furbearer records, a shorter time frame, and technological developments over the past decade. The objective would be to review current knowledge of distribution, habitat requirements, and agency monitoring practices of all mammalian carnivore species in the watershed. Time does not allow examination of museum records for all species as was done for reptiles and amphibians.

Current Activity

This project has been completed. The report is in final revisions and will be posted (www.d.umn.edu/~rmoen) when revisions have been approved. The review of current knowledge indicated that the documented presence of many species is spotty because of reporting issues rather than these species not being found in the Lake Superior watershed. Carnivores in the Lake Superior watershed can be divided into species that are present in northern portions (e.g., Canada lynx, wolverine), species that are present in the south (e.g., bobcat, gray fox), and species that are present throughout the watershed (e.g., black bear, mink). A common monitoring protocol that can be employed across the Lake Superior satershed is recommended to document status of each carnivore species.

Principal Investigator(s)

Ronald Moen

Project Sponsor(s)	Amount	Account	Active	
Great Lakes Indian Fish & Wildlife Comm	5,000	3006-10430-00013286	08/01/2009	08/01/2010
Total	$5,000			

Start Date: 08/01/2009 **End Date:** 08/31/2011 **Project ID:** 1558

Minnesota Breeding Bird Atlas

Objective

To complete a systematic count of breeding birds in all townships in the state of Minnesota as part of the Minnesota Breeding Bird Atlas. The methodology will allow samples to be gathered in the future in a representative and repeatable fashion.

Background

Minnesota is one of only six states in the U.S. that does not have a breeding bird atlas. An atlas is important to define the distribution and abundance of breeding species throughout the state. It will be useful for conservation planning and environmental impact assessment.

Previous Activity

CWE field staff recently completed the first two years of an anticipated six-year effort in the development of the Minnesota Breeding Bird Atlas – the first-ever statewide survey of Minnesota‘s breeding birds. Our objectives were to gain uniform statewide coverage for all of Minnesota‘s birds, estimate breeding bird populations by habitat type, and contribute to a nationwide network of bird atlases in the United States. During the last two breeding seasons (2009 and 2010) we sampled 40% of Minnesota townships (>920). We observed over 200 species of birds and counted over 78,000 individual birds in over 950 townships and in over 2,800 individual point counts. CWE bird censusers also contributed thousands of observations to the Minnesota Atlas data base in the complementary study organized by Audubon Minnesota. This represented over 4,000 probable or confirmed breeding records for Minnesota birds.

Current Activity

During the winter of 2011, data gathered during 2009 and 2010 were summarized. Many qualified bird observers were identified, primarily graduate and undergraduate students at the University of Minnesota. Breeding birds were sampled in over 700 townships with over 2,000 point counts from May 27 to July 15, 2011. Because these data collection efforts were recently completed, they have not yet been analyzed. These data are currently being double-entered and error-checked to insure accurate information. Species observations will also be scrutinized by several experts to insure that they are correct.

Principal Investigator(s)

Annie Bracey
Gerald Niemi

Project Sponsor(s)		Amount	Account	Active	
LCCMR		101,000	3015-10429-00000576	07/01/2008	06/30/2010
LCMR		161,000	3015-10429-00019124	07/01/2010	06/30/2012
	Total	$262,000			

Start Date: 07/01/2008 **End Date:** 06/30/2012 **Project ID:** 1529

Monitoring Birds in Great Lakes National Forests

Objective

To develop strategies to monitor the abundance of forest bird populations.

Background

Forest bird populations are a key biological indicator of the health and stability of forest ecosystems. Recent evidence suggests that some North American species are declining in abundance, in particular, Neotropical migrants or species that breed in North America and winter in Central or South America. With the increased interest and awareness of the status of Neotropical migrant birds in the United States, several organizations have developed strategies to monitor abundance of these species. We have established monitoring programs in three Great Lakes national forests: Chippewa (1993), Superior (1991), and Chequamegon (1992). Long-term monitoring will give us information on species abundance patterns over time and data will be used to identify species that are significantly increasing or decreasing in abundance.

Previous Activity

Trend analysis through 2009 indicated that 16 species increased across all three national forests over the past 19 years, while nine species declined. Increases in populations are still detected in permanent resident species such as Blue Jay, Black-capped Chickadee, and Red-breasted Nuthatch. Ground nesting species continue to be the most prominent species that have declined in population; they represent six of the nine species that are declining. Field crews and preparations are being made for the 2010 field season.

Current Activity

Field season for 2011 has been completed.

Principal Investigator(s)

Annie Bracey
Gerald Niemi

Project Sponsor(s)	Amount	Account	Active	
US Dept of Agriculture	198,710	1635-186-6037-00	05/01/1991	12/31/1995
USDA/Nicolet National Forest	30,000	1637-189-6129-00	01/01/1996	12/31/1996
USDA/Nicolet National Forest	49,000	1637-189-6146-00	05/01/1997	04/30/1998
Chequamegon/National Forest	49,000	1637-189-6171-00	05/01/1998	10/31/1999
USDA/Chequamegon/Nicolet National Forest	98,000	1637-189-6187-00	05/01/1999	04/30/2001
USDA/Forest Service	290,554	1637-189-6219-00	05/01/2001	12/31/2005
USDA Forest Service	61,148	1637-189-6294-00	05/19/2006	12/31/2006
USDA Forest Service	66,156	1637-189-6327-00	04/15/2008	12/31/2008
USDA Forest Service	66,156	3002-10429-00011308	05/15/2009	12/31/2009
USDA Forest Service	70,000	3002-10429-00018489	04/01/2010	12/31/2010
USDA Forest Service	54,307	3002-10429-00024474	06/02/2011	05/31/2012
Total	$1,033,032			

Start Date: 05/01/1999 **End Date:** 09/30/2012 **Project ID:** 420

Prevention and Early Detection of Invasive Earthworms

Objective

Our goal is to use a multi-pronged approach to reduce the introduction and spread of invasive earthworms through rigorous quantification of the relative importance of different vectors of introduction for earthworm species, develop and test the effectiveness of management recommendations for resource managers to limit the spread and introduction of earthworms, and to inform and actively engage diverse stakeholders in efforts to accumulate distributional data on invasive earthworm and their relative impacts across the state/region and to identify earthworm-free and minimally impacted areas worthy of protection.

Background

We propose to identify, describe, and quantify the potential vectors of in-state spread of established earthworm species and of interstate transport and introduction of non-established earthworm species.

Management recommendations will be field tested to determine the cost-benefit and relative effectiveness of different recommendations to actually limit the spread/introduction of different earthworm species. Project partners will collaborate to identify, describe and prioritize a list of management recommendations they want to explicitly test. Sampling methods and protocols will be developed for each and field testing/sampling will be conducted in 2010.

In cooperation with governmental agencies, a plan for regulatory responses will be developed to respond to early detection of earthworm species not already established in the state.

Effort involving research and educational institutions, governmental agencies, non-governmental organizations and citizen science will inform and involve diverse stakeholders to identify earthworm-free and minimally invaded areas of the state/region in order to prioritize protection efforts and provide rapid detection and response for new species introductions.

Previous Activity

Protocol-based internet searches and KAP studies (knowledge, attitudes, and practices) of potential target audiences was finished in 2010.

A KAP study has been developed and was delivered at five conferences this year.

Earthworm species profiles are being developed for all 16 species in the –Earthworms of the Great Lakes" book; development and implementation of protocols for handling earthworm survey data and voucher specimens has been finalized; workshops are now being scheduled; several hundred new citizen-based data points have been added to our database across the Great lakes region.

Current Activity

Principal Investigator(s)

Cindy Hale

Project Sponsor(s)	Amount	Account	Active	
Legislative Comm on MN Research	150,000	3015-10424-00007735	07/01/2009	06/30/2012
Total	$150,000			

Start Date: 07/01/2009 **End Date:** 06/30/2012 **Project ID:** 1545

Reducing Human-mediated Spread of Non-native Earthworms

Objective

Background

The long-term goal of this integrated proposal is to reduce substantially the rate of spread of damaging, invasive earthworms in northern hardwood forests. Specifically, this project will quantify the effect of bait labels on bait disposal behavior in the population of anglers. Anglers visiting fishing resorts and anglers purchasing bait at bait shops will be the two sample groups, and behavior will be measured directly by counting the number of containers placed in a bait disposal bin at the resorts, and indirectly through written surveys in both groups. We will use this information to estimate the consequent reduction in human-mediated spread of earthworms into hardwood forests which will be directly related to the benefits of using bait labels.

Previous Activity

Beginning in 2010, we established an experiment at fishing resorts in north central Minnesota to observe how anglers dispose of bait, given labelled and unlabelled bait containers. A crew of undergraduate interns managed the experiment, and also conducted independent studies related to invasive worm species, on topics related to tournament regulations to state policy.

Current Activity

The experiment continued in summer 2011, with an effort to increasing response from angler surveys.

In addition, NRRI initiated a survey of boat landings within a 15 mile corridor of Hwy 53 from Virginia to Cook, MN. The intent of the survey is to quantify degree of earthworm impact in forests adjacent to the landings, along with a characterization of forest overstory and ground-flora composition and an assessment of forest soils.

Principal Investigator(s)

Cindy Hale
George Host

Project Sponsor(s)	Amount	Account	Active	
Dept of Entomology(USDA Food&Ag Prime)	50,000	3002-11022-00011812	02/01/2010	01/31/2013
Total	$50,000			

Start Date: 02/01/2010 **End Date:** 01/31/2013 **Project ID:** 1649

Restoring Moose Foraging Habitat in Lake Superior Upland

Objective

Restore moose foraging habitat in Lake Superior upland

Background

Moose populations in the western portion of the Lake Superior Watershed may be declining. Annual mortality rates of adult cows are much higher than in other moose populations. We will restore over 200 acres of moose foraging habitat. We will also evaluate moose use of previously restored foraging habitat, and test how moose wearing GPS collars use restored sites, and how far moose will move from thermal cover to forage. Funds will only be used for habitat restoration and measuring moose use of restored habitat because the GPS collar project is funded by the Minnesota LCCMR.

Previous Activity

We did contracts to restore about 200 acres of moose foraging habitat and monitored browse intensity at several sites in northeastern Minnesota.

Current Activity

The habitat restoration on Lake County forestry land was accomplished in December 2010 and January 2011. In midwinter we measured browsing intensity and sampled bites in areas where GPS collared moose were foraging. This measured the actual forage availability to moose on the landscape. This spring when the snow was gone we measured overall browse removal in the winter on some of these sites as well as other sites. The net effect was that browse removal was locally higher than expected, and there were other areas with relatively low browse removal.

Principal Investigator(s)

Ronald Moen

Project Sponsor(s)	Amount	Account	Active	
Environmental Protection Agency	193,432	3002-10430-00015901	08/16/2010	09/30/2013
Total	$193,432			

Start Date: 08/16/2010 **End Date:** 09/30/2013 **Project ID:** 1608

Statewide Ecological Ranking of CRP Lands

Objective

Identify Minnesota lands with high habitat quality that may be taken out of the Conservation Reserve Program

Background

This project will identify and rank the ecological value of CRP and other critical lands throughout Minnesota using soil productivity, landscape, water, wildlife, and other relevant natural resource factors.

Previous Activity

We are acquiring and analyzing soil productivity data in light of the critical habitat information generated through Minnesota's Statewide Conservation and Preservation Plan (SCPP). Our collaborators have generated a crop productivity index that will determine the probability of land being removed from the CRP program.

By intersecting critical habitat with the above data sets, we can identify individual land parcels that can be targeted for acquisition, conservation easements, or other land preservation policies.

Current Activity

We integrated the habitat mapping conducted through the SCPP with the soil erosion and water quality risk maps. The habitat mapping was performed to synthesize the available information for Minnesota for prioritizing important areas for conservation (protection, acquisition, restoration). Key data included features such as known occurrences of rare species, sites of biodiversity significance, or high levels of game species abundance.

Habitat, soils and water quality data were were integrated into an Environmental Benefits Index, which maps lands of high conservation value, with the intent of identifying lands that may be withdrawn from the Conservation Reserve Program (CRP).

We created an online interactive web application that provides natural resource managers a means to visualize and interact with a high resolution map of the spatial data layers. Managers have the ability to specify the relative importance of habitat, soil erosion potential, or other components of the EBI, and view how the ecological ranking of parcels changes under different scenarios.

This information can inform the targeting of conservation activities to best balance land conservation, surface water quality and economic objectives.

Principal Investigator(s)

George Host

Project Sponsor(s)	Amount	Account	Active	
MN Board of Water & Soil Resources	4,000	3005-10424-00022632	03/19/2009	06/30/2011
MN Board of Water & Soil Resources	14,000	3005-10424-00022631	03/19/2009	06/30/2011
MN Bd of Water & Soil Res (Prime LCMR)	46,000	3005-10424-00015205	07/01/2009	06/30/2011
MN Board of Water and Soil Resources	15,000	3005-10422-00009516	03/19/2009	06/30/2011
MN Board of Water and Soil Resources	14,000	3005-10422-00009514	03/19/2009	06/30/2011
Total	$93,000			

Start Date: 03/19/2009 **End Date:** 06/30/2011 **Project ID:** 1569

The North Shore Data Consortium: Acquiring and Distributing High-Resolution Geospatial Information

Objective

To create the North Shore Data Consortium - a group of local and regional government and industry officials with the goal of collaborating on the collection and use of high-resolution spatial data, including LiDAR.

Background

There are strong local and regional interests in the acquisition and distribution of high-resolution spatial data needed for land use planning, natural resource management, and environmental assessment. Included among these data are LiDAR imagery, which provides very high resolution (0.5 to 1 m) digital elevation models, high resolution digital aerial photography products and derivative products such as hierarchically structure watersheds, topographic moisture indices, and refined wetland classifications. We propose to create the North Shore Data Consortium (NSDC), with the purpose of developing specific funding strategies and timelines for collecting LiDAR and contemporary high-resolution aerial photography for the region. The Consortium will develop memoranda of understanding among local, state and federal agencies and interested NGOs to provide for data sharing and leveraging of funds for contracting LiDAR acquisition. The NSDC will also identify data gaps and future data needs. To ensure compatibility with statewide data standards, we will work closely with the Ditigal Elevation Committee of the Governor's Council on Geographic Information Systems.

Previous Activity

NRRI scientists gave a presentation on the North Shore Data Consortium at the 19th annual MN GIS/LIS conference, held Oct 21-23, 2009. This conference provided an opportunity to introduce the project and connect with many potential members of the NSDC. We also had several internal project meetings and conversations with MN DNR and MN Sea Grant to discuss the project.

Current Activity

We convened the first formal meeting of the North Shore Data Consortium in January 2010, with several meetings that followed. The group, consisting of county, state, tribal, and university personnel, identified potential applications of LiDAR data for the north shore.

The NSDC collectively wrote a letter to the MN DNR providing a rationale for accelerating LiDAR data collection, currently scheduled for 2012, to spring 2011. This request will be discussed at the state's Digital Elevation Committee August 2010 meeting.

NRRI also provided support to NOAA, who was soliciting requests for segments of the Lake Superior shoreline to be flown under a NOAA initiative. NRRI developed a Google Map application that allowed users to highlight segments of the Lake Superior coast and annotate the reason for prioritizing these sites. The final map was subsequently delivered to NOAA.

Principal Investigator(s)

George Host
Lucinda Johnson

Project Sponsor(s)	Amount	Account	Active	
MN`s Lake Superior Coastal Program	39,137	3013-10424-00007525	09/04/2009	12/31/2011
Total	$39,137			

Start Date: 09/04/2009 **End Date:** 12/31/2011 **Project ID:** 1568

Weather and Water: Combining Broadcast Meteorology and Stream Data Animations to Protect Superior

Objective

The intent of this proposal is to deliver information on stormwater and other Lake Superior issues through broadcast media.

Background

Coastal communities across the northern Great Lakes are increasingly facing _tipping points‘ – points at which trout can no longer live in a stream due to thermal stress, beaches become unswimmable due to fecal coliform violations, or streams require development of TMDL remediation strategies because they have exceeded threshold turbidity levels. Lake Superior is particularly sensitive to increased pressures related to development of primary and secondary homes and the associated problems of stormwater management.

The intent of this proposal is to deliver information on stormwater and other Lake Superior issues through broadcast media. Broadcast meteorologists typically have the broadest and most in-depth science backgrounds of news staff and are also trained to communicate science to the general public. Since weather (rainfall amount and intensity; snowfall; air temperature; wind in regard to lake mixing; et al.) is one of the strongest drivers of runoff amount, quality, and seasonal and year-to-year variability, meteorologists have great potential to educate the public about water pollution in the context of their routine forecasts and explanations.

Previous Activity

A future story on potential impacts of climate change is under development.

Current Activity

Two additional stories aired in February 2011 on NorthlandsNewsCenter that focused on proper use of winter deicing agents (salt) and abrasives (sand) and how they act as pollutants to fish and other stream critters when washed into streams in high amounts.

We are developing a data vignttes webpage with links to real-time data and examples of important sets of historical environmental data that can be easily accessed by people (including the news media)

Principal Investigator(s)

George Host
Richard Axler

Project Sponsor(s)		Amount	Account	Active	
MN Sea Grant		37,000	1000-10424-20882-016438	04/08/2009	12/31/2011
	Total	$37,000			

Start Date: 07/01/2009 **End Date:** 12/31/2011 **Project ID:** 1588

A Whole-lake Assessment of Long-term Human Impacts to Lake Superior

Objective

This study will enable us to track pronounced local and global influences in the Lake Superior depositional basins and build a tangible understanding and awareness of how human activity has and continues to change environmental quality. Our analyses of depositional cores will better describe the effects of local and global stressors and the sensitivity of the lake to these stressors. Analyses of historical trends will be performed in the context of past and current retrospective studies and we will ensure that results are effectively communicated to the public and managing agencies. Our findings will provide support for and encourage sustainable environmental practices and will demand progressive action from policy makers. Better understanding will lead to more informed decision making, balancing potential short term economic benefit with long term ecological degradation.

Background

Lake Superior is the least studied and understood of the Great Lakes in terms of water quality changes and human influence. Lake Superior is unique among the other Great Lakes in size, retention time, lower basin development, and consequently, apparent preservation of water quality. It is the only Great Lake with an aquatic food web that is not considered severely impaired. However, there is evidence that the quality of Lake Superior is changing and, unfortunately, little is known about how human activity is affecting the lake as a whole. We aim to put contemporary data in a long-term context by investigating the paleolimnology of Lake Superior.

Previous Activity

Sediment cores have been collected throughout the Lake Superior basin and these cores have been processed for sediment dating and diatom analysis. Diatom, geochemical and pollen analyses on sediment samples are ongoing.

Current Activity

Sediment cores have been collected throughout the Lake Superior basin and these cores have been processed for sediment dating and diatom analysis. Diatom, geochemical and pollen analyses on sediment samples are ongoing.

Amy Kireta presented the project and preliminary results at the International Association for Great Lakes Research (IAGLR) Conference. Results are being compiled and will be presented at the North American Diatom Symposium in September by Victoria Chraibi (WRS graduate student).

A new article integrating paleoecological materials from Lake Superior is in press:
Reavie, E.D., L.E. Allinger 2011. What have diatoms revealed about the ecological history of Lake Superior? Aquatic Ecosystem Health and Management (in press).

Principal Investigator(s)

Euan Reavie

Project Sponsor(s)		Amount	Account	Active	
MN Sea Grant		93,201	1000-10425-20857-000169	02/01/2010	07/31/2011
	Total	$93,201			

Start Date: 07/01/2010 **End Date:** 06/30/2012 **Project ID:** 1591

Developing a Diagnostic Tool for Assessing Excessive Sediment Harm to Stream Communities

Objective

To create an indicator of harm to stream biotic communities due to excessive fine sediments.

Background

A number of north shore streams are on the MPCA impaired waters list because of erosion, sediment deposition, and turbidity problems. Excess sediment deposits reduce habitat space for the aquatic macroinvertebrates upon which fish feed, and make spawning more difficult for gravel-spawning fishes.

Our goal is to develop a suite of metrics using stream macroinvertebrate community condition specific to fine sediment deposition. The end result will be a tool that allows water quality managers to determine if sediments are causing biological impairments in streams. The diagnostic tool will help us determine the amount that excess sediment deposits are contributing to any impairment found when macroinvertebrate communities are sampled, even if sediment amounts are not high when samples are collected. Because this sediment-specific tool will be developed using standard invertebrate sampling methods, it can be used to re-evaluate historic datasets for streams of interest. Including historic data will give us an idea of how much sediment deposition contributed to past stream problems, and whether the severity of these effects has changed over time.

Previous Activity

Sediment sampling was completed at all sites five times across a permanent transect at each riffle at each site to track how sediment sizes and embeddedness changed over the course of the summer after various sizes of storm events. The data collected included precipitation amount, current velocity, bankful width, turbidity, temperature, pH, conductivity and dissolved oxygen. The stream bed grain size distribution was measured using a Wolman Pebble Count in conjunction with percent composition in sediment size classes in 0.25 sq. m quadrats across the transect. Percent embeddedness was also estimated within each quadrat. Additionally, a sediment sample was collected to determine the size composition of fine sediments (sands, silts, and clays). We collected macroinvertebrate samples at all 22 stream sites between mid-August and the end of September.

Current Activity

Much of the stream sediment sample data have been entered into spreadsheets. Streams covered a range of embeddedness, from not at all embedded, to 25% embedded. The Wolman pebble count and quadrat size classification were compared and used to find the median grain size. The size distribution is one of the sediment characteristics that will be linked to macroinvertebrate traits. Unfortunately, the two different methods used to measure stream substrate size do not compare well with each other, indicating that they cannot be used interchangeably.

Almost all invertebrate samples have been picked and most have been identified. Samples were picked and identified to lowest taxonomic unit possible, usually genus (except for Chironomidae). Data are being entered into spreadsheets and then moved into a database.

Principal Investigator(s)

Valerie Brady

Project Sponsor(s)	Amount	Account	Active	
MN`s Lake Supr Coastal Prog (USDOC NOAA)	47,997	3013-10426-00017075	08/16/2010	12/31/2011
Total	$47,997			

Start Date: 08/16/2010 **End Date:** 12/31/2011 **Project ID:** 1622

Duluth Residential Stormwater Reduction Demonstration

Objective

Determine whether property-owner-based stormwater reduction practices are effective in reducing peak stormwater runoff in Duluth due to the cold climate, clay soils, and surficial bedrock.

Background

We propose to demonstrate the effectiveness of residential Best Management Practices (BMPs) at reducing stormwater runoff problems for Lake Superior tributaries. We will install residential BMPs in a subwatershed in an older residential neighborhood and compare the runoff to that of a similar control subwatershed without stormwater BMPs. The neighborhoods identified for the program are located in the Lester-Amity stream system that is on the Minnesota 303(d) list for turbidity. Tributaries receiving the runoff from the targeted neighborhoods/subwatersheds are being severely eroded by high peak flows and deliver highly turbid water to Amity Creek. Water flow, temperature, and turbidity measurements will be taken within storm sewers in both subwatersheds before and after BMP installation, requiring three full field seasons of work. Flow, temperature, and turbidity data from storm sewer flow will be posted and interpreted on the educational Lake Superior Streams website, as will final results. Resident knowledge of runoff issues, solutions, and responsibilities will be evaluated at the beginning and end of the project. Results from this demonstration project should be applicable throughout the Great Lakes.

Previous Activity

During summer 2009 stormwater BMPs were provided for about 22 properties in the area chosen for treatment. These included planting (and protecting from deer) more than 250 trees and shrubs with wildflowers between to reduce yard space for folks to mow; 5 rain gardens; 22 rain barrels; 6 rock-filled sumps; and aeration on 20 yards. Most of the work was done by the Minnesota Conservation Corps youth and young adult crews, supervised by Center for Water and the Environment scientists, Duluth utilities department, Barr Engineering, and South St. Louis Soil and Water Conservation District personnel. MCC personnel also dug several long trenches, re-dug a stormwater ditch, and installed 5 ditch checks to improve and clean up stormwater flow.

Current Activity

Monitoring equipment (flow, temperature, conductivity, and turbidity) was installed in the three neighborhood storm sewer systems again for the ice-free season of 2010. These data will be compared to the pre-installation data from 2008 to determine how much stormwater runoff has been reduced from the treatment street properties.

In addition, two rain garden workshops were taught during summer 2010, with the construction of one additional rain garden for each workshop. There were approximately 15 participants in each workshop and they helped plant the rain gardens. Rain gardens constructed in 2009 look very good and appear to be functioning well.

Principal Investigator(s)

Richard Axler
Valerie Brady

Project Sponsor(s)		Amount	Account	Active	
City of Duluth (MPCA Prime)		121,482		02/27/2008	06/30/2011
	Total	$121,482			

Start Date: 02/27/2008 **End Date:** 06/01/2011 **Project ID:** 1528

Ecological Design for the St. Louis River Area of Concern

Objective

To develop an ecological design for restoring the Fish and Wildlife Service 40th Avenue West project area.

Background

The lower 21 miles of the St. Louis River, the largest U.S. tributary to Lake Superior, form the 4856 ha St. Louis River estuary. Despite the effects of more than 100 years of industrialized and urban development as a major Great Lakes port, the estuary remains the most significant source of biological productivity for western Lake Superior, and provides important wetland, sand beach, forested, and aquatic habitat types for a wide variety of fish and wildlife communities.

The St. Louis River Alliance Habitat Plan identified several sites within the AOC with significant habitat limitations. One of these sites, the ~~–~~40th Avenue West Habitat Complex" was identified by a focus group within the SLRA Habitat Workgroup as a priority for a ~~–r~~emediation-to-restoration" project.

NRRI scientists are working with the SLRA Habitat Workgroup to develop an "Ecological Design" that will be used to develop remediation and restoration plans for the 40th Ave site.

Previous Activity

This is a new project.

Current Activity

In late summer and fall of 2010, CWE scientists conducted a comprehensive sampling of vegetation, macroinvertebrates, and birds within and around the 40th Avenue project area. This work is summarized in NRRI Technical Report NRRI/TR-2010/24.

The NRRI Geographic Systems Laboratory assembled a suite of spatial data relevant to the development of an ecological design which include bathymetry, substrate, wind fetch, as well as locations of all sample points.

The GIS data coupled with field information will be used to develop a statistical model predicting the occurrence of submerged and emergent aquatic vegetation. This model will provide a guide toward identifying remediation efforts to restore habitat within the 40th Ave project area.

Principal Investigator(s)

George Host
Lucinda Johnson

Project Sponsor(s)		Amount	Account	Active	
USDI Fish and Wildlife Service		143,980	3002-10426-00019490	08/01/2010	09/30/2011
	Total	$143,980			

Start Date: 08/01/2010 **End Date:** 09/30/2011 **Project ID:** 1620

GIS Techical Assistance to Support Great Lakes Sea Lamprey Management

Objective

To develop on-line tools to assist Great Lakes fisheries managers in visualizing and interpreting lamprey data.

Background

Sea lamprey are a long-established invasive species in the Great Lakes, and states and provinces have numerous agencies and efforts to control lamprey populations. Yet no single agency has a mandate to synthesize data on a Great Lakes basinwide basis. The goal of this project is to develop on-line data synthesis and visualization to help managers understand the distribution of lamprey and lamprey control measures. The tool will help target future control efforts, as well as further public education on the lamprey issue.

Previous Activity

This is a new project.

Current Activity

We have developed a set of potential map outputs including control agent maps (lampricide, barriers, trapping locations) as well as wounding rates, lamprey observations and telemetry information.

We developed a description for a graduate student research position, likely through the Water Resources Science program, and are contacting potential candidates.

Principal Investigator(s)

George Host

Project Sponsor(s)	Amount	Account	Active	
LLO (prime: Gr Lakes Fishery Comm)	11,672	3006-10351-00024797	07/01/2011	06/30/2012
Total	$11,672			

Start Date: 07/01/2011 **End Date:** 06/30/2012 **Project ID:** 1648

GLEI II - Indicator Testing and Refinement

Objective

The GLEI-II project will focus on wetland near shore conditions of the Great Lakes, and consist of five tasks:

1) Refine coastal ecosystem indicators from previous monitoring programs through calibration against updated landscape/land use information within the entire Great Lakes basin, 2) test the temporal and geographic integrity of existing Great Lakes indicators. Determine scores for a suite of metrics from sites not sampled previously, and test the applicability of metrics across the entire Great Lakes basin, including Canada, 3) test and compare analytical techniques to cross-calibrate indicators from concurrent monitoring programs, 4) evaluate indicators for cost-effectiveness, 5) implement a data collection, analysis, and reporting system for recommended indicators. Implement a web-based reporting system that integrates landscape/land use information systems, and 6) Create a map of baseline conditions for the Great Lakes basin based on historical and current monitoring information.

Background

A comprehensive basin-scale suite of biological, chemical, and habitat indicators throughout the Great Lakes ecosystems, along with monitoring plans for the long-term measurement, will provide valuable information on Great Lakes. Better understanding the condition of this vast resource is vital to the parties charged with administering the agreement (e.g., International Joint Commission, Great Lakes Water Quality Board, Great Lakes Science Advisory Board).

Previous Activity

This is a new project.

Current Activity

The process for selecting Great Lakes coastal wetlands to obtain updated calculations on various human disturbance variables was completed. From this effort, a prioritized set of sample locations were identified and submitted to various state agencies for collection permit approval. Cooperative efforts with a Coastal Wetland Consortium effort has been established. The project QAPP was approved by February 2011.

During the next reporting period, approximately 40 Great Lakes coastal wetlands will have received overlap monitoring efforts for birds, amphibians, fish, macroinvertebrates aquatic vegetation, habitat characterization, and water quality sampling. Numerous other locations will also be monitored for birds, amphibians, and water quality due to less time restriction per location. Analysis key to the refinement of indicators will commence as updated GIS coverages are introduced, and further effort is realized on fish and invertebrate data from previous sampling efforts. During the next reporting period, staff will have been trained and approved for field collection, various data will be immediately available following site visits, and laboratory sample processing will be underway.

Principal Investigator(s)

Dan Breneman
Lucinda Johnson

Project Sponsor(s)	Amount	Account	Active	
Environmental Protection Agency	1,625,769	3002-10426-00018842	08/01/2010	01/31/2014
Total	$1,625,769			

Start Date: 08/01/2010 **End Date:** 01/31/2014 **Project ID:** 1625

GLOS Enhanced Tributary Monitoring to Support AOC and LaMP

Objective

Our project will design, install and operate two or three monitoring stations, coordinated with two to three more to be installed by the new Superior National Estuarine Research Reserve in the St. Louis River Estuary/Area of Concern. This is one of five Great Lakes projects funded by GLRI-NOAA to develop remote and real-time water quality and biological monitoring that can be integrated into a Great Lakes wide network of data collection, visualization, and dissemination. The project lead is Dr. Jay Austin at the University of Minnesota Duluth Large Lakes Observatory with assistance from NRRI (R. Axler and J.Henneck).

Background

GLOS has developed the Nearshore/Tributary Monitoring Network as a strategic program designed to ~~"~~protect, restore, and manage coastal ecosystems more effectively." Habitat protection and restoration is a major objective outlined in the Great Lakes Regional Collaboration strategy report, with an ultimate goal of improving wetlands function for up to 1.1 million acres across the region. Meanwhile, threats to ecological sustainability are rapidly increasing, such as the introduction of invasive species and land use transformation across the region. As we work to protect and restore natural ecosystems, more information is needed to better understand the restoration impacts and connections between tributary, nearshore and open lake areas. Access to increased, comprehensive, and coordinated data about the interactions of these systems can help resource manager and other stakeholders make better informed decisions about how to manage and restore the beneficial uses of these ecosystems.

Previous Activity

This is a new project.

Current Activity

A multi-agency/organization technical advisory committee was formed. The first site will be the Superior Entry channel between Allouez Bay and Lake Superior. A station site was identified and mounting design developed for presentation to the Army Corps of Engineers and U.S. Coast Guard. Project lead, Jay Austin, has ordered instrumentation for the site and G. Clark (Wisconsin Sea Grant) and R. Garano (Lake Superior National Estuarine Research Reserve manager) are helping with siting permits

Principal Investigator(s)

Richard Axler

Project Sponsor(s)	Amount	Account	Active	
Environmental Protection Agency	30,570	3014-10423-00023580	09/01/2010	11/30/2011
Total	$30,570			

Start Date: 09/01/2010 **End Date:** 11/30/2011 **Project ID:** 1644

Great Lakes Beach Information Communication System

Objective

To develop real-world and on-line warning systems to alert beachgoers to real-time rip current conditions

Background

Previous Activity

Current Activity

Principal Investigator(s)

George Host
Jesse Schomberg

Start Date: 08/01/2010 **End Date:** 05/31/2014 **Project ID:** 1647

Great Lakes Biological Monitoring: Phytoplankton

Objective

The primary objectives of the Great Lakes phytoplankton program are to: 1) collect phytoplankton from the Great Lakes; 2) identify and enumerate phytoplankton, maintaining quality assurance standards; 3) maintain a database of phytoplankton data; 4) interpret phytoplankton data, including evaluation of long-term trends in phytoplankton and food web dynamics; 5) dissemination of data and interpretations through reports, presentations, peer-reviewed journals and on the internet.

Background

Phytoplankton are known to respond to stressors such as nutrient loading and invasive species. We will take a comprehensive approach to GLNPO's Biological Monitoring program for the Great Lakes using proven sampling and evaluation techniques. New and long-term phytoplankton data will be used to track shifts in the offshore biological community related to natural and anthropogenic influences.

The research will characterize and evaluate phytoplankton communities throughout the Great Lakes. Analyses of these data in concord with long-term sampling data, and other project data (e.g., zooplankton, water quality) will provide interpretations of stressor influences on lake biology. A database of detailed, quality-assured phytoplankton data will be provided for contemporary and future evaluations of Great Lakes condition.

Previous Activity

All 2007 through 2010 pelagic Great Lakes samples have been collected, prepared and analyzed for phytoplankton. Spring 2011 sampling is currently under way. A detailed database of pelagic Great Lakes algae is under development and we have initiated development of a SOLEC indicator that will use algal monitoring data to track pelagic condition in the lakes.

Current Activity

All 2007 through spring 2011 pelagic Great Lakes samples have been collected, prepared and analyzed for phytoplankton. Summer 2011 sampling is currently under way. A detailed database of pelagic Great Lakes algae is under development and we are continuing development of a SOLEC indicator that will use algal monitoring data to track pelagic condition in the lakes.

Sample assessments show that significant changes have occurred in the Great Lakes food web over the last decade in response to establishment of non-native dreissenids and changing water quality. In particular, algal density and biomass are decreasing basin-wide, with the exception of Lake Erie which shows significant blooms of diatoms in the spring. These shifts are being examined for causes and trophic linkages. Two articles from this study have been accepted and are in press:

Reavie, E.D., R.P. Barbiero 2011. Recent changes in abundance and cell size of pelagic diatoms in the North American Great Lakes. Phytotaxa (in press).

Reavie, E.D., S. Juggins 2011. Sample size and diatom-based indicator model performance in three North American phosphorus training sets. Aquatic Ecology (in press).

Principal Investigator(s)

Euan Reavie

Project Sponsor(s)		Amount	Account	Active	
Environmental Protection Agency		1,000,000	1628-189-6315-00	03/01/2007	02/28/2012
	Total	$1,000,000			

Start Date: 03/01/2007 **End Date:** 02/28/2012 **Project ID:** 1487

Great Lakes Coastal Wetland Monitoring

Objective

To assess the biotic condition of all the major coastal wetlands of the Great Lakes, U.S. and Canadian shorelines.

Background

Building on the indicators developed by the Great Lakes Coastal Wetland Consortium and the Great Lakes Environmental Indicators Project, this project will now assess the baseline biotic condition of all the major coastal wetland complexes along the coasts of the Laurentian Great Lakes. Biotic communities to be assessed include birds, frogs, fish, aquatic invertebrates, aquatic macrophytes, along with supporting water quality and habitat. This project will spend 5 years sampling and assessing coastal wetlands around the Great Lakes using crews based in Duluth, Green Bay, Michigan/Indiana, New York, Windsor, and eastern Ontario.

Previous Activity

The winter was spent carefully writing a Quality Assurance Project Plan (QAPP) for EPA GLNPO that included very detailed information on how samples will be collected, processed, and handled, and how all project teams will ensure the quality of the data they collect. Quality assurance will be ensured through rigorous training and oversight, and through a number of data checks before the data are released and used. The QAPP was signed by EPA at the end of March.

The NRRI GIS lab created a site selection system that was used by all collaborators across the Great Lakes to virtually review and select sites appropriate for sampling. There were 1039 sites selected for the five years, with approximately 208 sites selected for the first year of sampling. NRRI fish/bug/veg crews will be sampling about 35 sites, while bird/amphibian crews will sample about 50 sites.

Field crews have been preparing for the field season, including preparing detailed standard operating procedures for all work, creating field data forms, obtaining appropriate sampling permits, coordinating with neighboring crews, and obtaining needed equipment and supplies.

Bird/amphibian sampling will begin in May.

Current Activity

Approximately 40 wetland complexes ranging from northeastern Lake Huron to the extreme western end of Lake Superior were sampled for amphibian and breeding bird populations. Data have been entered in an on-line interactive program. Data will begin to be analyzed during fall 2011. Niemi will be reporting on the activity regarding breeding amphibian and bird population sampling in Great Lakes coastal wetlands at a meeting in Traverse City, Michigan in late August 2011.

Principal Investigator(s)

George Host
Gerald Niemi
Lucinda Johnson
Richard Axler
Valerie Brady

Project Sponsor(s)	Amount	Account	Active	
Central Michigan University (EPA Prime)	179,353	3014-10429-00023385	09/10/2010	08/31/2015
Central Michigan University(EPA Prime)	139,643	3014-10426-00023387	09/10/2010	08/31/2015
Central Michigan University(EPA prime)	72,153	3014-10426-00018810	09/10/2010	08/31/2015
Central Michigan University(EPA prime)	79,421	3014-10424-00023381	09/10/2010	08/31/2015
Central Michigan University (EPA Prime)	25,596	3014-10423-00023390	09/10/2010	08/31/2015
Total	$496,166			

Start Date: 09/01/2010 **End Date:** 08/31/2015 **Project ID:** 1605

Impacts of Land Development and Climate Change on Lake Superior`s North Shore Trout Habitat

Objective

1) Characterize the current hydrology of North Shore streams, including precipitation and streamflow trends, water budgets, and the relative importance of different baseflow sources.
2) Characterize current stream temperature regimes in North Shore streams using a combination of deterministic models for select study sites and empirical models for broader spatial coverage. 3) Forecast future streamflow and temperature regimes in North Shore streams based on expected changes in land use and in climate. Short term forecasts can be made based on current trends, and long term forecasts can be made based on available climate and land use change data.

Background

Both land development and climate change are expected to impact aquatic habitat (flow, temperature) in North Shore streams. Changes in land use can impact stream habitat via changes in riparian vegetation, modifications to the stream channel itself, increases in surface runoff rate and volume, and loss of hydrologic storage in surface and ground water. Climate change can impact stream habitat via changes in the stream flow regime due to changing precipitation patterns, including intensity and seasonal distribution, and changes in surface water temperatures due to increases in air temperature and humidity. To develop long-term strategies to address these impacts, state agencies and local watershed managers will need information on both the potential extent of the impacts and the physical mechanisms for the impacts.

Previous Activity

This is a new project.

Current Activity

Next month the PIs will discus the success of accessing existing data, preliminary analysis of those data available, and prioritizing tasks to individuals responsible for generating additional data for model development.

Principal Investigator(s)

Lucinda Johnson

Project Sponsor(s)	Amount	Account	Active	
MN Department of Natural Resources	79,930	3005-10426-00024831	05/26/2011	02/28/2012
Total	$79,930			

Start Date: 05/26/2011 **End Date:** 02/28/2012 **Project ID:** 1643

Lake of the Woods Paleolimnology Assessment

Objective

Lake of the Woods has been placed on Minnesota`s impaired list for nutrients and eutrophication indicators, so the future of the lake has become a high profile concern for the Ontario and Minnesota governments and the lake`s diverse group of stakeholders. Research recommendations and data gaps suggested that improved coordination of monitoring efforts and the construction of a long-term ecological reconstruction for the lake were logical steps in management of the resource. NRRI`s objective in this investigation is to collect sediment cores and use archived materials to provide long-term trends and trajectories of lake conditions for use in resource management.

Background

Previous Activity

Current Activity

This project is getting started. Candidate sediment core locations have been selected, and field work for sample collection will begin this fall.

Principal Investigator(s)

Euan Reavie

Project Sponsor(s)		Amount	Account	Active	
MN Pollution Control Agency		72,461	3005-10425-00017805	06/30/2011	06/30/2012
	Total	$72,461			

Start Date: 06/30/2011 **End Date:** 06/30/2013 **Project ID:** 1646

Lake Superior Beach Monitoring and Notification Program

Objective

Assist the Environmental Protection Agency funded, Minnesota Pollution Control Agency directed Lake Superior Beach Monitoring and Advisory program for 2010.

Background

The Natural Resources Research Institute was contracted by the Minnesota Pollution Control Agency to carry out the Minnesota Lake Superior Beach Monitoring and Advisory Program for 2010. After the field season ended the agency transferred the program to the Minnesota Department of Health for 2011 and beyond if funding continues to be received from the Environmental Protection Agency. NRRI was contracted by the health department to operate the www.mnbeaches.org website in 2011.

Previous Activity

Data from 2010 were compiled and reported in an annual report submitted to the Minnesota Pollution Control Agency in Duluth for submission to EPA (also published as an NRRI technical report). We also compiled all of the historical data for each beach site along with graphs for explanatory and exploratory statistical analyses.

Current Activity

Data received from the Minnesota Department of Health are being uploaded onto the www.mnbeaches.org website and notifications sent out by email to dozens of interested parties if health risk criteria are exceeded. We are also a part of a MN Sea Grant project funded via the EPA‘s Great Lakes Restoration Initiative called the Great Lakes Beach Information Communication System. G. Host, senior research associate in the Center for Water and the Environment is directing the NRRI component of the project which will develop a model beach report system to synthesize various sources of digital information from a single beach into a single report, and
automatically generating summary notices for distribution to beach users through a variety of
formats. The system will produce daily beach reports during the recreation season
based on automated and manual monitoring data, forecasts/nowcasts, and volunteer data collection, and that if dangerous conditions are reported during the day, an automatic report will be distributed, warning of the changing conditions.

Principal Investigator(s)

Richard Axler

Project Sponsor(s)	Amount	Account	Active	
Minnesota Pollution Control Agency	67,299	3013-10423-00019684	08/16/2010	09/30/2010
MN Dept of Health	5,000	3005-10423-00024552	06/01/2011	09/30/2011
Total	$72,299			

Start Date: 08/16/2010 **End Date:** 09/30/2011 **Project ID:** 1624

Lake Superior Streams Sediment Assessment

Objective

Background

This project will develop a TMDL process that links water quality standards used for TMDLs and aquatic health responses in the water system, including links back to watershed landscape factors, such as soil and land use. This effort focuses on turbidity and measurable surrogates, such as suspended sediments.

NRRI's portion of this work involves delineating of watershed boundaries, assembling relevant geospatial data, and quantifying natural environmental and human disturbance gradients. These data will be used to identify reference condition watersheds and support the design of a monitoring strategy to assess stream conditions along the north shore.

Previous Activity

This is a new project

Current Activity

An ArcHydro delination of watersheds was applied to north shore watersheds. Geospatial data layers assembled for this project included slope, soils, geology, drainage area, stream length and order, land use and road density.

These factors were integrated into a anthropogenic/environmental stressor index. Relationships between the index and stream water quality measurements are being evaluated.

Principal Investigator(s)

George Host

Project Sponsor(s)		Amount	Account	Active	
MN Pollution Control Agency		75,000	3005-11032-00011331	06/18/2009	06/30/2011
	Total	$75,000			

Start Date: 06/18/2009 **End Date:** 06/30/2011 **Project ID:** 1634

Landscape Metrics for Coastal Wetland Integrity Indices

Objective

To test existing landscape indicators of coastal marsh integrity that can be incorporated into a coastal wetland monitoring program. Using the same set of coastal marshes selected for the USGS project we will:
1) Evaluate the ability of individual landscape indicators to discriminate between reference, disturbed, and managed sites.
2) Analyze redundancy among landscape indicators and between landscape and site specific indicators.

Because funds for monitoring are often tight, it is advantageous to maximize the amount of information relative sampling costs in a monitoring program. For example, it would not be wise to monitor more than one variable that conveyed the same information. Thus, one part of developing a multi-metric assessment is to evaluate redundancy among indicators. If there are indicators that are highly redundant, then the variable that is more expensive to monitor or is less useful may be eliminated from consideration.

Background

The National Wildlife Refuge System includes 161 coastal refuges on 1,045,925 acres of coastal marsh. The majority of these marshes have experienced some form of anthropogenic alteration such as oil spills, chemical mosquito control, drainage for mosquito control, salt hay farming, introduction of invasive species, restricted tidal flow, road construction, or channelization. These alterations impact both the intrinsic value of coastal marshes as well as the quality of marsh habitat for the unique wildlife they support.

Tools for the assessment of ecological condition remain underdeveloped for these ecosystems. Such tools are critically needed to guide decisions regarding protection, management, and restoration. The most meaningful and useful assessments of ecosystem condition are based on reliable indicators of ecosystem integrity that are integrative across several spatial scales and levels of biological and environmental organization.

Neckles et al. (2008) listed >50 measurable attributes for coastal marshes that could serve as indicators for coastal marsh condition. USGS is evaluating the response of candidate indicators within coastal marshes on 15 NWRs throughout the Atlantic and Pacific coasts of the U.S. In conjunction with site specific indicators, there is a need to evaluate landscape indicators for this same set of coastal marshes.

Previous Activity

Examples of wetland characteristics that can be used as landscape indicators: landscape position, wetland size, wetland exposure, habitat heterogeneity, connectivity, surrounding land use, wetland morphology, and human use.

Wetland monitoring was conducted in 13 National Wildlife Refuges, with sampling in reference, disturbed and managed areas. Landscape data and metrics were acquired across the regions.

Current Activity

Additional landscape indicator metrics are being derived and analyzed to evaluate redundancy among variables as well as the ability of each variable to discriminate between reference, disturbed, and managed sites.

Principal Investigator(s)

Jennifer Olker
Lucinda Johnson

Project Sponsor(s)		Amount	Account	Active	
USDI US Geological Survey		64,330	3002-10426-00012660	08/01/2009	09/30/2011
	Total	$64,330			

Start Date: 08/01/2009 **End Date:** 09/30/2011 **Project ID:** 1561

Low Impact Development on the North Shore: Lessons Learned

Objective

We propose to: 1) operate the LakeSuperiorStreams.org (LSS) sentinel stream network and its easy access web portal for disseminating water resource information, interpretive materials, and Regional Stormwater Protection Team information to the public to understand the environmental, public health and regulatory issues related to North Shore stream condition as affected by land use management; 2) develop an enhanced LID toolkit for LSS to document what LID techniques have been used, develop web- and print materials to explain local examples, hold a workshop with local/regional experts, and develop a `virtual tour` of LID projects in the area, with photos and videos including discussions with project designers, builders, and owners about the practices.

Background

This project continues funding for the LakeSuperiorStreams.org project via the NOAA/MDNR funded Lake Superior Coastal Program. Its goal is to improve environmental literacy and decision-making in regard to regional water resource issues by providing online public access to real-time water quality data and other relevant data and interpretive information. It also will update its Site Design Toolkit which provides comprehensive information for homeowners, business owners, communities, contractors, and landscape/development associated businesses regarding low impact development associated best management practices for reducing stormwater runoff and erosion. Major partners include: the city of Duluth, MPCA-Duluth, WLSSD, the S. St Louis SWCD, and the Superior RSPT.

Previous Activity

We maintained real-time automated stream water quality and flow gauging instrumentation at 4 Duluth area trout streams with 15 minute data posted to the LSS website- available to the public in various formats incl. an interactive plotting and animation tool. Data collected since 2002 are being been analyzed and related to suspended sediment, mercury, and phosphorus levels to both characterize stream condition and their sediment, nutrient, and mercury loading to the near shore zone of Lake Superior and the St. Louis River estuary (2 publications). Regional low impact design LID practices for stormwater control and erosion reduction have been inventoried, and photographed for a National LID Practices Atlas, accessed via interactive on-line maps. The project hosted the Northland Innovative Stormwater Conference in Nov 2010 that presented information about innovative stormwater management practices applicable to our region.

Current Activity

* Maintained real-time automated stream water quality & flow gauges at 4 Duluth area trout streams - data posted at www.lakesuperiorstreams.org; * Programming upgrades have been made to facilitate using the DataViewer graphing tool for other data sources; Filming/interviewing at LID sites in Summer 2011; * Numerous project related technical presentations have been made at local, state, and national/international conferences and with news media * Continued development of a semi-automated data vignettes library for open use.

Principal Investigator(s)

Richard Axler

Project Sponsor(s)	Amount	Account	Active	
MN`s Lake Sup Coastal Prog (USDOCNOAA	89,987	3013-10423-00007522	09/04/2009	12/31/2011
Total	$89,987			

Start Date: 09/04/2009 **End Date:** 12/31/2011 **Project ID:** 1567

Managing the Nations Fish Habitat at Multiple Spatial Scales

Objective

Objective 1: To refine empirical and mechanistic models for predicting extent of cold water fish habitat under current land use and climate regimes. Predict oxythermal habitat for coldwater fish species using an empirical model incorporating existing land use, lake morphometry, and climate data. Test single lake mechanistic model (Stefan and Fang, ongoing) predicting temperature and hypolimnetic oxygen concentrations using historic physical, water quality, and cisco abundance data for a subset of Minnesota‘s stratified lakes. Refine model to accommodate predictions of additional cold water fish species habitat, beyond cisco.

Objective 2: Predict future extents of cold water fish habitat in lakes of the Glacial Lakes region under future climate and land use scenarios. Develop predictions of the potential to retain oxythermal habitat in lakes under changing land use for distinct lake classes and/or geographic regions using an empirical model. Develop predictions of the potential to retain oxythermal habitat in individual lakes under changing land use for distinct lake classes and/or geographic regions using a mechanistic model.

Background

Coldwater fish communities are especially vulnerable to eutrophication and the effects of climate change. Climate warming has the potential to reduce coldwater fish habitat by direct warming in unstratified lakes and increased hypolimnetic oxygen depletion in stratified lakes from extended periods of stratification and thermocline deepening (Schindler et al. 1996; Stefan et al. 1996; Magnuson et al. 1997; Fang et al. 2004).

Deep lakes with large, oxygenated hypolimnions may represent important sanctuaries for coldwater species such as cisco. Projected range reductions for cisco would allow for the identification of high priority refuge lakes. Once identified, lake watershed protection efforts could be directed at refuge lakes to prevent further anthropogenic impacts. Conservation efforts could be enacted to prevent increased nutrient loading that would change the trophic state of these refuge lakes and thereby threaten hypolimnetic oxygen levels.

Previous Activity

Successful regression models predicting phosphorus concentrations in lakes are going. Phosphorus is a key variable in the empirical model predicting the depth at which appropriate oxygen concentrations can be found for cold water fishes. Efforts are now ongoing to develop an integrated model for all three states. These empirical models will be used with predictions of future land use and climate to predict the availability of cold water habitat in lakes across the three states.

Current Activity

Current efforts are focused on 1) refining empirical models to predict the threat of increased nutrient loads to lakes, and 2) predicting responses of lakes to increased nutrient loads under current climatic conditions.

Principal Investigator(s)

Lucinda Johnson

Project Sponsor(s)	Amount	Account	Active	
USDI CESU Coop Ecosystem Study	177,727	3002-10426-00015141	01/19/2010	12/31/2010
Total	$177,727			

Start Date: 01/19/2010 **End Date:** 12/31/2011 **Project ID:** 1563

Near-Term Design for the Great Lakes Coastal System for Great Lakes Environmental Research Lab, Ann Arbor, MI

Objective

The Great Lakes Observatory System (GLOS) is an effort dedicated to providing wide internet access to real-time and historic data on the hydrology, biology, chemistry, geology and cultural resources of the Great Lakes, its interconnecting waterways and the St. Lawrence River. The near-term design effort will map the path forward for the next five years of GLOS evolution. The GLOS architecture will clearly lay out the necessary steps for implementation of a completely responsive and flexible system that also leverages existing investments in GLOS and partner sensors.

Background

Previous Activity

This is a new project.

Current Activity

NRRI's task in GLOS development has included: (1) characterization of "model regions" that represent the types of zones that could be characterized by observational data; (2) compilation of a list of indicators or "sensors" that could be measured and/or queried using the GLOS.

Principal Investigator(s)

Euan Reavie
Lucinda Johnson
Richard Axler

Project Sponsor(s)	Amount	Account	Active	
Limnotech (Prime USDOC NOAA)	37,000	3010-10426-00020775	10/04/2010	06/13/2011
Total	$37,000			

Start Date: 10/04/2010 **End Date:** 06/13/2011 **Project ID:** 1626

Prioritizing Wetland Restoration for Water Quality and Habitat Improvement

Objective

Background

Current thinking suggests that wetlands with a catchment area of approximately 5 times the size of the basin represent the most likely opportunities for reliable and sustainable water quality improvement (http://www.bwsr.state.mn.us/wetlands/Restoration_Strategy.pdf); however, watershed delineations for individual wetlands require highly resolved topographic data that are not yet available state-wide. Thus, we will use a two-tiered approach to identify at-risk regions within major watersheds and next, for a set of test watersheds (pilot 8-digit HUCs) across the state, we will identify individual wetland complexes with high potential for performing multiple beneficial functions.

The project will consist of five tasks: (1) compile existing spatially-defined anthropogenic stressor and natural feature data for the entire state, 2) summarize spatial data and appropriate stressor metrics at the subcatchment watershed (14-digit) scale and rank order the disturbance gradients within each of the 81 major watersheds, 3) apply empirical models to evaluate and prioritize potential wetland restorations based on expected water quality and habitat improvement in a pilot set of major watersheds, and 4) develop a decision tool to enable local officials and project advocates to select wetland complexes with the greatest potential for maximizing water quality improvement, along with other wetland values. Finally, (5) in a targeted set of major watersheds (1-3) where high resolution elevation data (LiDAR) exists we will test the increased predictive power of delineating specific catchments for individual wetlands or wetland complexes to improve restoration prioritization. This GIS-based prioritization system will allow managers to identify and target local areas where wetland restorations are both most likely to be successful and suitable to contribute to improved downstream water quality and provide local or regional habitat.

Previous Activity

This is a new project.

Current Activity

Activities have focused largely on 1) development of a literature review, 2) development of a detailed work plan, and 3) acquisition of spatial data needed to identify at-risk regions where wetland restoration for the purpose of water quality enhancement will be most beneficial. In addition, project personnel have made contact with personnel engaged in similar projects around the state to coordinate activities where possible.

Principal Investigator(s)

Jeremy Erickson
Lucinda Johnson
Terry Brown
Valerie Brady

Project Sponsor(s)		Amount	Account	Active	
MN Pollution Control Agency		250,000	3005-10426-00022003	03/14/2011	06/30/2013
	Total	$250,000			

Start Date: 03/14/2011 **End Date:** 12/31/2011 **Project ID:** 1627

Research Development Testing and Evaluation Facility for Ballast Treatment in the Great Lakes Region

Objective

The Great Ships Initiative (GSI) is a innovative collaboration whose objective is to end the problem of ship-mediated invasive species in the Great Lakes-St. Lawrence Seaway System, including through independent research and demonstration of environmental technology, financial incentives and consistent basin-wide harbor monitoring. The NRRI`s task in this effort is to develop, test and apply methods to evaluate the effectiveness of candidate treatments systems in their ability to exterminate algae and protozoans.

Background

The near-term objective of the GSI is to significantly accelerate research, development and implementation of effective ballast treatment systems for ships that visit the Great Lakes from overseas. To that end, the GSI has established research capabilities at three scales—bench, land-based, and shipboard. Each scale is dedicated to addressing specific evaluation objectives, with protocols as consistent with the International Maritime Organization (IMO) and federal requirements as practicable.

NRRI`s role in the GSI is to test candidate ballast water systems to ensure they are able to meet the IMO`s criteria for mortality of the microorganisms carried in ballast water.

Previous Activity

Several candidate treatment systems have been tested and several reports to vendors and regulators have been provided (www.greatshipsinitiative.org)

2011 efforts are just beginning. In addition to testing of candidate systems we are evaluating the contents of actual ships in the Great Lakes to determine the continued potential for non-native species introductions.

Current Activity

Several candidate treatment systems have been tested and several reports to vendors and regulators have been provided (www.greatshipsinitiative.org)

2011 efforts are well under way. We are finishing anonymous testing on "Government Furnished Equipment" (GFE) for consideration as a ship-board treatment alternative. Ship-board testing is also under way, and we have been tracking the activities of two Great Lakes ships in order to sample real ballast water and attempt preliminary treatment system activities.

Several presentations related to the project comprised a session at the International Association for Great Lakes Research (IAGLR) conference.

Principal Investigator(s)

Euan Reavie

Project Sponsor(s)	Amount	Account	Active	
University of Wisconsin Superior	30,000	1673-189-6311-00	01/22/2007	12/31/2007
University of Wisconsin Superior	17,497	1673-189-6323-00	12/01/2007	05/31/2008
Northeast Midwest Institute	249,932		06/01/2008	04/30/2012
Total	$297,429			

Start Date: 01/22/2007 **End Date:** 04/30/2012 **Project ID:** 1469

Restoring Impaired Lake Superior Tributaries: Stormwater BMP Evaluation, Education, and Outreach

Objective

Our primary goal is to coordinate with local agency remediation/BMP projects and the existing Chester, Kingsbury, Tischer, Amity and Poplar Creek/River automated water quality monitoring and public education effort carried out by the LakeSuperiorStreams.org project to demonstrate their effectiveness at reducing stormwater runoff problems as indicated by upstream-downstream and before-after water quality and biological monitoring.

Background

Urban Duluth streams are generally similar to the less developed watersheds of the North Shore with >70% forested, similar geology and hydrology, and in the case of Amity in particular, the potential for increased development pressure. Therefore, Duluth's streams can serve as pilot-watersheds for evaluating restoration, mitigation and planning strategies for use in protecting more pristine, but developing, North Shore streams.

Previous Activity

Water quality surveys were made during base and high flow periods above and below the Graves Road Creek site and the East Branch Amity site from 2007-2011; bug, fish, and habitat data were collected during mid-summer each year. These data will establish a baseline for comparison with post-restoration data to determine the measurable benefits of the projects. We have three years of baseline data and one year of post-BMP data although re-vegetation activities will not happen until 2011. Data are being analyzed for a final report. Additional data were collected at the Miller Creek sediment trap from 2007-2010 to assess its efficiency.

Current Activity

Additional water quality sampling in spring and summer 2011 was conducted at all sites. A synoptic survey of near simultaneous (<1 hr) sediment related water quality was conducted at >20 sites throughout the Amity Creek watershed on 4/11/2011 during spring snowmelt runoff. All data have been summarized and a final report for the project submitted to Minnesota Pollution Control Agency. Since there has only been one year of post construction monitoring, it is too early to assess in-stream effects at the Amity restoration sites. Additional funding was secured for data collection in 2011. The Miller Creek Mall sediment trap was determined to have no significant effect on stream turbidity, suspended sediment or conductivity. Soft sediment accumulation rates were estimated and recommendations made to local agencies for benchmark survey work.

Principal Investigator(s)

Dan Breneman
Richard Axler

Project Sponsor(s)		Amount	Account	Active	
MN Pollution Control Agency		103,553	1662-189-9023-00	02/01/2007	06/30/2011
	Total	$103,553			

Start Date: 02/01/2007 **End Date:** 06/30/2011 **Project ID:** 1511

St. Louis River Watershed Streams and Lakes: Water Quality Biological Monitoring

Objective

The overall project goal is to develop complementary (same year) physical, biological and chemical data sets for a range of Minnesota Pollution Control Agency-prioritized streams and lakes in northeast Minnesota and to process and/or compile historical, but modern, water quality and biological data into the overall state database.

Background

Water quality, biological, and habitat data are critical for identifying status and trends that may reflect short and long-term water resource impairments in response to impacts at local, regional, and global scales such as urbanization, agriculture and forestry practices, invasive species introductions, atmospheric deposition, and climate change. Ideally, since field collections are costly, sampling designs and types of assessment data are best selected by considering multiple benefits and efficiencies. NRRI is assisting the Minnesota Pollution Control Agency in assessing the condition of St. Louis River watershed lakes (14) and streams (34) by collecting intensive water quality information and summer habitat, macroinvertebrate (bug) and fish data.

Previous Activity

All field sampling has been fished, quality assured, and submitted to Minnesota Pollution Control Agency for use in assessing the conditions in subwatersheds of the St. Louis River watershed. We are now compiling water quality, habitat, macroinvertebrate (bug), and fish data to determine (1) how well do the stressor gradient measures of condition correlate with the measured values for biological organisms, water quality, and habitat condition. We are also conducting a study comparing bug data collected using two different types of sampling methods that are both being used in the region.

Current Activity

A final report with all the data was submitted to the Minnesota Pollution Control Agency in June 2011. Statistical analyses related to invertebrate sampling protocol differences used by the agency's assessment team versus NRRI and Environmental Protection Agency methods are in progress. We are also evaluating differences in the sampling design used by the Minnesota Pollution Control Agency in comparison with NRRI's stressor gradient-based design. Results will be compiled into a separate NRRI technical report and then developed into a manuscript for a peer-reviewed journal because of the uniqueness of this project.

Principal Investigator(s)

Dan Breneman
Lucinda Johnson
Richard Axler
Valerie Brady

Project Sponsor(s)		Amount	Account	Active	
MN Pollution Control Agency		302,067	3005-10423-00009742	05/13/2009	06/30/2011
	Total	$302,067			

Start Date: 05/13/2009 **End Date:** 06/30/2011 **Project ID:** 1542

Stressor Gradients and Spatial Narratives of the St. Louis River Estuary

Objective

Provide an assessment of reference and at-risk aquatic habitats in the St. Louis River watershed and estuary to guide future monitoring, restoration, remediation, land use planning, along with community awareness and stewardship.

Background

The St. Louis River estuary, simultaneously an EPA area of concern and soon to become Superior National Estuarine Research Reserve, is a complex mosaic of high quality plant, animal, and aquatic habitat intermingled with areas of heavy industrial use, contaminated sediments, and effluents from an urban landscape. Communities surrounding the estuary are actively developing land use plans that will set the course for their future environmental and socioeconomic health, and it is imperative that local decision makers have access to data, tools and technologies that allow them to make the best decisions for their communities.

Previous Activity

Scientists and educators from University of Minnesota Duluth (NRRI and Sea Grant), Bemidji State University, University of Wisconsin-Madison (Landscape Architecture, Sea Grant, Curriculum and Instruction, Local Games Lab), and University of Wisconsin-Superior (Natural Sciences) are collaborating via both MN and WI Sea Grant funding to provide an assessment of reference and at-risk aquatic habitats in the St. Louis River watershed and estuary to guide future monitoring, restoration, remediation, land use planning, along with community awareness and stewardship.

We began a program of systematically characterizing water quality, and plant and macroinvertebrate communities along a watershed-based human stressor gradient, and using the results to map reference and at-risk sites within the estuary. This gradient is being used to help build spatial narratives through multifaceted land, ship, and Internet-based outreach and collaborative learning activities designed to communicate results to a wide variety of targeted end users, including youth, teachers, citizens, managers, and local decision makers. Communication and education tools include an open geospatial archive, a _deep map' that incorporates vignettes of local communities, augmented reality games and geo-tours of the estuary, ship-based activities, and a diverse array of complementary online resources.

Current Activity

We sampled more than 20 streams entering the St. Louis River estuary for water quality, macroinvertebrates, and wetland vegetation. Water quality data was collected within the estuary, at the mouth of the stream, and further up in the tributary to understand differences between overland flow and Lake Superior-influenced water masses. Samples were analyzed over winter and spring, and preliminary results presented at the St. Louis River Summit, held in February 2011.

We held numerous strategy session with Wisconsin colleagues to devise geo-tour and other outreach strategies associated with the scientific data collection. A draft website was developed and is currently being coded.

Principal Investigator(s)

George Host
Richard Axler

Project Sponsor(s)		Amount	Account	Active	
MN Sea Grant		110,311	1000-10424-20857-000169	02/01/2010	07/31/2011
	Total	$110,311			

Start Date: 07/01/2010 **End Date:** 06/30/2012 **Project ID:** 1590

SWAG 2011 Superior Basin Lakes

Objective

This project will generate physical and chemical water quality information for three lakes that the Minnesota Pollution Control Agency has included in their list of `Targeted Lakes` for assessment in the 2011 and 2012 field seasons. NRRI`s Center for Water and the Environment has a long-term interest in identifying status and trends that may reflect short and long-term trends in response to impacts at local, regional, and global scales such as urbanization, agriculture and forestry practices, invasive species introductions, atmospheric deposition, and climate change.

Background

The Clean Water Legacy Act Surface Water Assessment (SWA) Grant Program has created funding for local organizations, universities and citizen volunteers to help MPCA assess the condition of Minnesota‘s streams and lakes. Water quality, biological, and habitat data are critical for identifying status and trends that may reflect short and long-term trends in response to impacts at local, regional, and global scales such as urbanization, agriculture and forestry practices, invasive species introductions, atmospheric deposition, and climate change. Ideally, since field collections are costly, sampling designs and types of assessment data are best selected by considering multiple benefits and efficiencies. NRRI was funded to collect seasonal limnological data from 3 Superior Basin lakes in 2011 & 2012.

Previous Activity

Lakes were sampled in May, June and July 2011. Water samples are being analyzed for various parameters.

Current Activity

Principal Investigator(s)

Richard Axler

Project Sponsor(s)		Amount	Account	Active	
MN Pollution Control Agency		16,283	3005-10423-00021410	03/15/2011	06/30/2013
	Total	$16,283			

Start Date: 03/15/2011 **End Date:** 06/30/2013 **Project ID:** 1621

Center for Water and the Environment

Personnel

Subhash Basak has joined the honorary editorial board of Reports in Theoretical Chemistry, an international, peer-reviewed, open access journal publishing original research, reports, reviews, and commentaries on all areas of theoretical chemistry.

Scientific Meetings/Presentations

Rich Axler gave an oral presentation titled "Global Great Lakes: transforming environmental data into anticipatory ecosystem management" at the University of Minnesota Institute on the Environment's "IonE's Outburst" held at the St. Paul Campus on Jan. 20. Co-authors include Bob Hecky, Norine Dobiesz, Jay Austin, and Steve Colman (LLO-UMD), George Host, Norm Will and Terry Brown, Cindy Hagley (Minnesota Sea Grant), Jason Antenucci (Centre for Water Research at the University of Western Australia), Oliva Mkumbo, and Dick Nyeko (Lake Victoria Fisheries Organization, East Africa).

The following NRRI staff took part in the St. Louis River Estuary Summit, held at the University of Wisconsin-Superior, Feb. 7-8: Jerry Niemi "Birds of the St. Louis River estuary," George Host "The St. Louis River estuary data slam," and poster presentations on multiple NRRI-led projects in the St. Louis River estuary from Lucinda Johnson, Valerie Brady, George Host, Rich Axler, Dan Breneman, Terry Brown, Elaine Ruzycki, Norm Will, Jerry Henneck, and Gerry Sjerven.

Ron Moen had his research about Canada lynx featured in an in-depth article in this month‘s issue of the DNR‘s Conservation Volunteer. It is available to read online.

Ron Moen, with Erika Butler (DNR Wildlife Veterinarian), spoke to the Minnesota Deer Hunters Association about the most recent research on moose in the Arrowhead region at the Cook County Community Center in Grand Marais on Apr. 11 and at Vermilion Community College on Apr. 12.

Euan Reavie gave a seminar titled ―What is the role of algae in the recent collapse of the Great Lakes food web?‖ and Reavie, Lisa Allinger, and Allegra Cangelosi (Northeast-Midwest Institute, Washington D.C.) presented a poster titled ―Assessing ballast water treatments: Viability assessment for ambient microplankton assemblages‖ at the 50th Northeast Algal Symposium, Woods Hole, Mass. held from Apr. 15-17.

Jennifer Olker received a Best Student Poster award for presenting ―Development, size, and gonadal endpoints differ in two native frog species exposed to atrazine and accelerated pond-drying‖ co-authored by Lucinda Johnson, Patrick Schoff and R. Johnson (EPA Mid-Continent Ecology Division), at the joint meeting of Midwest Chapter of the Society of Environmental Toxicology and Chemistry and Chicago Regional Chapter of the Society for Risk Analysis, held at Lake Geneva, Wis. from Mar. 23-24.

Christopher Chizinski (University of Minnesota, St. Paul campus) Anna Peterson, JoAnn Hanowski, Charles Blinn (University of Minnesota, St. Paul campus), Bruce Vondracek (U.S. Geological Survey), and Gerald Niemi published ―Breeding bird response to partially harvested riparian management zones‖ in the journal Forest Ecology and Management June 2011 issue.

Many NRRI scientists presented information at the 54th Annual Conference on Great Lakes Research, held in Duluth, MN, May 30-June 3:
Oral presentations included:
1) ―Weather, water, and people: water quality data animations to protect Lake Superior streams and coastal zones,‖ Rich Axler, George Host, Norm Will, Jerry Henneck, Elaine Ruzycki, Gerry Sjerven, Cindy Hagley (MN Sea Grant), Todd Carlson (City of Duluth), Chris Kleist (City of Duluth), Jay Austin (Large Lakes Observatory), Norine Dobiesz (Large Lakes Observatory), Bob Hecky (Large Lakes

Observatory), Jesse Anderson (MN Pollution Control Agency), Tim Tuominen (Western Lake Superior Sanitary District), H. Bauman (MN Pollution Control Agency), and J. Magyar (MN Pollution Control Agency).
2) "The Lakeside stormwater reduction project: evaluating the impacts of a paired-watershed study on local residents," Karlyn Eckman (Water Resources Center, University of Minnesota), Valerie Brady, Jesse Schomberg (MN Sea Grant), and Valerie Were (Water Resources Center).
3) "A high-resolution, scalable index of anthropogenic stress for Great Lakes watersheds," George Host, Terry Brown, Tom Hollenhorst (EPA-MED), Jan Ciborowski (University of Windsor, Ontario), Lucinda Johnson and Rich Axler.
4) "Lake Superior ecological history and current trajectory as told by diatoms," Amy Kireta, Euan Reavie, Lisa Allinger, and Victoria Chraibi.
5) "The influence of landscapes on Great Lakes coastal ecosystems," Gerald Niemi.
6) "Protists in ballast water: assessment methods and performance of a candidate ship-board treatment system," Euan Reavie, Allegra Cangelosi (Northeast-Midwest Institute), and Lisa Allinger.
7) "Sediment, phosphorous and mercury loads from four western Lake Superior watersheds," Elaine Ruzycki, Rich Axler, Jerry Henneck, Norm Will, and George Host.

Poster presentations included:
1) "Lakesuperiorstreams.org: making stormwater and stream data come alive for citizens, students, teachers, contractors, resource agencies, decision-makers and scientists," Rich Axler, George Host, Norm Will, Jerry Henneck, Elaine Ruzycki, Gerry Sjerven, Cindy Hagley (MN Sea Grant), Jesse Schomberg (MN Sea Grant), Todd Carlson (City of Duluth), Chris Kleist (City of Duluth), Tim Tuominem (WLSSD), Jesse Anderson (MN Pollution Control Agency), Amber Westerbur (MN Coastal Program/ Minnesota DNR), and Keith Anderson (South St. Louis SWCD).
2) "Using North Shore streams and benthic macroinvertebrates to develop an indicator of stream impairment due to excess sediment," L.S. Herrera (Water Resources Sciences, University of Minnesota) and Valerie Brady.
3) "Land use/land cover and hydrologic effects on North Shore Superior tributary water quality," Andrea Crouse, Rich Axler, George Host, Jeremy Erickson, and Lucinda Johnson.
4) "Stressor gradients and spatial narratives of the St. Louis River estuary," George Host, Rich Axler, Nick Danz and Jeff Schuldt (University of Wisconsin-Superior), David Hart (University of Wisconsin-Madison/Sea Grant), Annette Drewes (University of Minnesota-Extension), Janet Silbernagel, Mark Wagler, and Jim Mathews (University of Wisconsin-Madison), Cindy Hagley and Jesse Schomberg (MN Sea Grant).
5) "Distribution of testicular oocytes within male Rana pipiens," Jennifer Olker, Patrick Schoff, and Rodney Johnson (EPA-MED).

Subhash Basak and Guillermo Restrepo (University of Pamplona, Colombia) edited a special hot topic issue of the international journal Current Computer Aided Drug Design entitled "Applications of graph theory, network theory, and chemotopology to structure-activity relationships and characterization of metabolic processes."

Lucinda Johnson gave a presidential address titled "Benefits and challenges of using multiple approaches and multiple scales for answering complex questions" at the North American Benthological Society held in Providence, R.I. from May 22 - 26. Johnson ended her tenure as president of the Society during which the organization voted to change its name to Society for Freshwater Science.

NRRI staff gave the following presentations at the Joint Meeting of Ichthyologists and Herpetologists held in Minneapolis on July 8:
1) Lucinda Johnson, "Multiscale approaches for quantifying effects of multiple stressors in aquatic ecosystems," with authors Jennifer Olker, Patrick Schoff, Glenn Guntenspergen (U.S. Geological

Survey), Cathy Johnson (U.S. Forest Service), Anna Rohweder Wagner (USDA North Central Agricultural Research Lab), Jason Rohr (University of South Florida) and Val Beasley (University of Illinois, Urbana-Champaign).
2) Jennifer Olker, ―Development, size and gonadal endpoints differ in two native frog species exposed to atrazine and accelerated pond-drying" with authors Lucinda Johnson, Patrick Schoff, and Rodney Johnson (EPA Mid-Continent Ecology Division).

Publications

Peer-reviewed:

Angradi TR, Bolgrien DW, Jicha TM, Pearson MS, Taylor DL, Moffett MF, Blocksom KA, Walters DM, and Elonen C. 2011. An assessment of stressor extent and biological condition in the North American mid-continent Great Rivers (USA). River Systems 19 (2): 143-163.

Basak SC, and Mills D. 2011. Quantitative structure-activity relationship studies of boron-containing dipeptide proteasome inhibitorsusing calculated mathematical descriptors. Journal of Mathematical Chemistry 49: 185-200.

Basak SC, Mills D, and Hawkins DM. 2011. Characterization of dihydrofolate reductases from multiple strains of plasmodium falciparum using mathematical descriptors of their inhibitors. Chemistry & Biodiversity. In press.

Basak SC, Zhu Q, and Mills D. 2011. Quantitative structure-activity relationships for anticancer activity of 2-phenylindoles using mathematical molecular descriptors. Current Computer-Aided Drug Design. In press.

Basak SC. 2010. Chemo-bioinformatics based mathematical descriptors and their applications in computational drug design. Current Computer Aided Drug Design. In press.

Basak SC. 2010. The role of mathematical chemodescriptors and proteomics based biodescriptors in drug discovery. Drug Development Research. In press.

Chizinski CJ, Peterson A, Hanowski JM, Blinn CR, Vondracek B, and Niemi GJ. 2011. Breeding bird response to partially harvested riparian management zones. Forest Ecology and Management 261: 1892-1900.

Evans DL, Niemi GJ, and Etterson MA. 2011. An overview of fall raptor banding at Hawk Ridge, Duluth, Minnesota U.S.A. - 1972-2009. Journal of Raptor Research. In press.

Host GE, Brown TN, Hollenhorst TP, Johnson LB, and Ciborowski JJH. 2011. High-resolution assessment and visualization of environmental stressors in the Lake Superior basin. Aquatic Ecosystem Health and Management. In press.

Kireta AR, Reavie ED, Sgro GV, Angradi TR, Bolgrien DW, Hill BH, and Jicha TM. 2011. Planktonic and periphytic diatoms as indicators of stress on great rivers of the United States: Testing water quality and disturbance models. Ecological Indicators. In press.

McCann NP, and Moen RA. 2011. Mapping potential core areas for lnyx (Lynx canadensis) using pellet counts from showshoe hares (Lepus americanus) and satellite imagery. Canadian Journal of Zoology 89: 509-516.

Merten EC, Finlay J, Johnson L, Newman R, Heinz S, and Vondracek B. 2011. Environmental controls of wood entrapment in upper Midwestern streams. Hydrological Processes 25: 593-602.

Natarajan R, and Basak SC. 2011. Numerical descriptors for the characterization of chiral compounds and their applications in modeling biological and toxicological activities. Current Topics in Medicinal Chemistry (11): 771-787.

Reavie ED, and Allinger LE. 2011. What have diatoms revealed about the ecological history of Lake Superior? Aquatic Ecosystem Health and Management. In press.

Restrepo G, Basak SC, and Mills D. 2011. Comparison of SAR and QSAR approaches to mutagenicity of aromatic and heteroaromatic amines. Current Computer-Aided Drug Design. In press.

Ruzycki EM, Axler RP, Henneck J, Will NR, and Host GE. 2011. Estimating mercury concentrations and loads from four western Lake Superior watersheds using continuous in-stream turbidity monitoring. Aquatic Ecosystem Health and Management. In press.

Reports:
NRRI/TR-2011/01. Exotic earthworm invasions: integrated research and education to achieve natural resource protection. C.M. Hale. Minnesota‘s Lake Superior Coastal Program.

NRRI/TR-2011/11. North Shore bat activity and habitat use. R. Moen, R. Abel. Minnesota‘s Lake Superior Coastal Program.

NRRI/TR-2011/12. Vegetation characterization and pine regeneration strategies for the Grand Portage National Monument. G.E. Host. National Park Service.

NRRI/TR-2011/13. Evaluating habitat use by moose with aerial photographs. R. Stever and R. Moen. UROP.

NRRI/TR-2011/19. A 16-year summary of breeding bird trends in national forests of northern Minnesota and Wisconsin - 1995-2010. Niemi, G.J., A. Grinde, J. Bednar, N. Danz, and M. Etterson. Chequamegon/Nicolet, Chippewa, and Superior National Forests.

NRRI/TR-2011/20. Beaver in the Grand Portage National Monument. Ron Moen. National Park Service.

NRRI/TR-2011/22. Assessment of habitat, biological condition, and water quality of the St Louis River watershed. Axler, R.P., D. Breneman, V. Brady, L. Johnson. MPCA.

NRRI/TR-2011/28. Predicting the impacts of development on Lake Superior North Shore streams using high resolution GIS spatial data. L Johnson, R. Axler, D. Breneman, T. Hollenhorst. Minnesota Sea Grant.

NRRI/TR-2011/29. Isolation and computational characterization of myxobacteria for the bioconversion of lignocellulosic biomass. Wensheng Qin in LU and Subhash C. Basak. Lakehead University-NRRI collaboration.

NRRI/TR-2011/31. Effects of soil compaction and organic matter removal on ground-flora diversity: seventeen-year results from the Chippewa National Forest long-term soil productivity project. C. Reschke and G. E. Host. USDA Forest Service.

NRRI/TR-2011/35. Lake Superior streams sediment assessment. T.N. Brown, G.E. Host, L.B. Johnson. MPCA.

NRRI/TR-2011/36. Duluth residential stormwater reduction demonstration project for Lake Superior tributaries. Valerie Brady. City of Duluth, MPCA prime.

NRRI/TR-2011/37. Restoring impaired Superior tributaries: stormwater BMP evaluation, education. and outreach. Richard Axler, Jerry Henneck, Dan Breneman, Elaine Ruzycki, and Andrea Crouse. MPCA, EPA prime.

Outreach

The Center for Water and the Environment hosted the following speakers at departmental Muffin Meetings:

- Sarah Crow, Kris Johnson, and Emily Peters, University of Minnesota's Institute on the Environment; Boreal forest and communities projects
- Ron Moen, CWE biologist; Moose research in northeastern Minnesota
- Suzanne Sanders, National Park Service ecologist; Vegetation monitoring at Isle Royale National Park
- Gerald Niemi, CWE senior research associate, Three shaky legs of the sustainability stool
- Adedeji Olufemi Bolarinwa, senior lecturer / consultant, Fish and Wildlife Diseases Department of Veterinary Public Health and Preventive Medicine, University of Ibadan, Nigeria; Aquatic pollution in Nigeria: the way forward
- Jerry Hembd, professor, University of Wisconsin Superior; Sustainable community development and ecosystem services: a recovering economist‘s view
- Stephen D Handler, climate change specialist, Northern Institute of Applied Climate Science, USDA Forest Service, Houghton MI; Northern Wisconsin climate change response framework
- Inka Keränen, Department of Biological and Environmental Science, University of Jyväskylä; Reproductive isolation in damselflies
- Okechukwu Ukaga, executive director U of M Northeast Minnesota Sustainable Development Partnerships, adjunct full professor, Geography Department, UMD, extension professor of sustainable development, U of M Extension; Building community-university partnerships for sustainability: the work of the U of M regional sustainable development partnerships
- Jamie Rogers, undergraduate at University of Birmingham and NRRI intern October 2010-June 2011; Adventures in environmental science from the University of Birmingham to Duluth - a study abroad placement at NRRI

NRRI Business Development

NRRI BUSINESS GROUP

NRRI has a mission to foster economic development of Minnesota's natural resources in an environmentally sound manner to promote private sector employment. As such, we have a range of stakeholders, from the individual entrepreneur with an idea to very large industry, such as mining and forestry. The NRRI Business Group focuses more on what can be referred to as NRRI's niche, or providing one-on-one entrepreneur/small business development, including the science behind taking an idea to proof of concept and even to industrial scales. There are two areas that can limit NRRI's ability to assist the entrepreneur/small business. The first is their limited financial ability to pay for the services we are capable of providing. But, if our scientists believe the idea has merit, preliminary market analysis indicates the idea meets a national need and the economics appear to make sense, we do what we can to help them out and even seek resources on their behalf (Product Development Fund and SBIR/STTR reference below). The second area is the perception of how intellectual property is handled in the event the research has patentable results. The University is a very large organization and has federal and state considerations that are incorporated into standard research agreements. For instance, researchers must have the right to publish their results. While this may be important to professors on a tenure track, the scientists at NRRI focus on transferring the knowledge to entities that have the ability to commercialize the technology (the entrepreneur) and do not have the same need to publish. The NRRI Business Group is doing what it can to work with the various offices throughout the University to develop agreements which capture the essence of what NRRI is about. Our work over the last five years has resulted in several successful research agreements and we continue to explore ways in which NRRI shares in upfront risks as well as shares in the rewards through a royalty structure in the event the client is successful with commercialization (patentable or not). We only win when our client wins. We are proud of where we have come and strive to make our process more entrepreneur/small business friendly. It is good for the entrepreneur, our region, state, and the United States to collaboratively develop and transfer knowledge and technology. The process takes time, but our experiences lead us to believe it is worth it.

The below activities encompass specific projects activities where the NRRI Business Group provided assistance.

Intellectual Property Portfolio

- Biodiesel Technology – A patent was issued for this technology. The principal investigator is Pavel Krasutsky. The base foundation for this technology is that an ethanol plant can improve its economics by extracting additional oil from the Dry Distillers Grain and Solubles (DDGS), thus creating High Protein DDGS and additional byproducts. NRRI was awarded $250,000 from UMN Initiative for Renewable Energy and the Environment (IREE) for one year of additional research to advance to an industrial level from 2010-2011. There are several commercial equipment and technology suppliers who are partnering with us on the project and are investing their own time and money in the technology scale-up because they believe in the program. IREE has partnered with the Corn Growers Association through their research grants process to fund the next round of commercialization experiments.
- Systemic Plant Conditioning Composition (SPCC) – The patenting process continues on this technology. The principle investigator is Tomas Levar, who has worked with collaborators from the private industry for several years. An Exclusive License Agreement was executed on November 23, 2009. The Licensee received approval through the Environmental Protection Agency and launched their product in Spring 2011. It is called Repellex Systemic Animal Repellent and is receiving substantial media attention, especially in Minnesota and Wisconsin where the deer make a salad out of hostas and other favorite garden varieties.

- Chemical Derivatives Laboratory – The UMN entered into an option agreement for a number of patents related to NRRI's birch bark technology to an entrepreneur who is very familiar with NRRI and our intellectual property capabilities. The entrepreneur is working with Dr. Krasutsky to assess the potential market and develop a business plan to attract investors.

NRRI Product Development Fund
The Knight Foundation and Blandin Foundation granted NRRI a total of $350,000 for product development initiatives. NRRI applied for the Blandin Foundation and Knight Foundation grant to be able to support the economic development efforts of entrepreneurs and/or small businesses in creating or retaining jobs with product development. NRRI has built an infrastructure over the last 25+ years which can support applied research efforts; however, NRRI is only able to provide a limited amount of technical support without payment for services. NRRI anticipated that entrepreneurs and/or small businesses would be willing to match any contributions from the Product Development Fund with cash and/or in-kind services and materials. A key outcome of the grant is to work with up to 30 businesses that will fully understand their proposed product's market which gives them the ability to evaluate and make a "go/no go" decision based on the on whether the economics of the product support a commercialization effort.

NRRI is on task with the major activities identified in the proposal. At 54 months into the grant period, direct results include private investment by the businesses who have received assistance, new products developed, jobs created and manufacturing efficiencies which have increased sales, The Product Development Fund has eleven completed projects, one closed project prior to completion due to scheduling conflicts for the client, and three active projects.

In addition to the investment by Blandin and Knight, each project required a cash and in-kind match. For the $277,705 awarded through the Product Development Fund, $834,459 private sector investment has been committed, plus $79,278.36 in-kind from UMD Natural Resources Research Institute.

For 2011, there is a balance of $72,295 for additional projects. NRRI received an extension from Knight Foundation (11/30/2011) and Blandin Foundation (6/1/2012) to develop the additional projects four projects in the application process.

Strategic Planning
The NRRI Business Group participates as part of the management team for strategic planning at NRRI. It was time to step back as an organization to intentionally and deliberately set our direction during this time of transition. This transition is multi-layered, from a large percentage of our seasoned management and staff approaching retirement age and a need for succession planning to the University of Minnesota Duluth (UMD) transitioning with a new Chancellor and organizational changes, where the University of Minnesota has a new President, and federal and state governments whirling from difficult economic times puts additional strains on availability of funding through research grants. As such, we have been meeting to discuss our Strengths, Weaknesses, Opportunities, and Threats (SWOT) and have engaged the entire staff to participate in focus groups as well. The goal is to complete a strategic plan by fourth quarter 2011, from which a marketing plan will be developed based on the strategic initiatives identified in the plan.

Grant Applications
The NRRI Business Group worked extensively with the Woods Material and Manufacturing group on a grant application to the Economic Development Administration (EDA) for the University of Minnesota Duluth (UMD) to be designated as a University Center for the state of Minnesota, worth roughly $2.2 million over a five year period. The approach utilized to develop the application included conversations across the state and with various departments within the University of Minnesota system to determine how best to provide the type of knowledge transfer and University partnering capabilities that were outlined in the solicitation. We received 21 letters of support from public and private entities throughout

Minnesota. If UMD is successful in being designated as the EDA University Center, its focus will be on the following activities to support the regions' economic development strategies: 1) Strengthen the technical entrepreneur support system to assist inventors (both internal UMD and external) with accelerating ideas to commercialization; manufacturing assistance to industry clusters and company specific programs; and, education, outreach, and application support to help innovative entrepreneurs learn how to access federal dollars (SBIR/STTR), 2) Technical assistance and access to interns to support the Regional Development Commissions/Economic Development Districts economic and business research studies, and 3) Network using information technology to leverage University partners to expand the economic vitality of Minnesota.

SMALL BUSINESS DEVELOPMENT ASSISTANCE

The NRRI supports the UMD Center for Economic Development (CED) for small business development assistance to those businesses focusing on the commercialization or conservation of natural resources. The assistance is related to business planning, financial planning, financing plans, marketing plans, ecommerce, etc, which complements the research and development activities at NRRI.
For the six months of January through June of 2011, 17 businesses with a base in natural resources or energy conservation were provided one-on-one consulting, of those, 9 have services or products relating to alternative energy production, particularly in the use of biomass or wood pellet production. Three of the businesses are involved with the commercialization and use of by-product stone from the regional mining operations, and one of them has secured contracts from throughout the Midwest and has been featured in several news stories.

Between January and June 2011, CED continued to assist businesses that would be considered "green," with the total in the first half of 2011 totaling 45. The industries included alternative energy using solar, wind or alternative fuels, energy saving initiatives, environmentally sustainable products and geo-thermal processes. Some of the current business strategies involve the development and manufacture of bio-fuels, marketing assistance for a sprinkler system that has been successfully used in the preservation of buildings during wild-fires, the development and application of equipment used in the solar energy industry, a bio-butanol project, and have included sustainable business practices into our ongoing business consulting package.

CED coordinated the regional effort to promote the Minnesota Cup Business Plan Competition sponsored by the University of Minnesota, Wells Fargo and the State of Minnesota and spoke with regional groups to encourage participation, particularly in the student division. This year NE Minnesota was presented with five entries into the semi-final round in the various categories.

One of the NRRI Product Development Fund recipients is also participating in the CED Business Incubator Program and continues to develop numerous business and financial projections with CED staff members. This business had been selected as a 2010 semi-finalist in the MN Cup competition and received assistance through CED. With the new investors and financing, this business has continued to explore market opportunities, including product licensing agreements. Another long-standing CED business also participated in the Product Development Fund initiative and gained information to use in manufacturing operations.

CED continues to partner with other regional providers to assist area businesses that are part of the aviation sector with business planning, marketing and financial support.

During the first half of 2011, CED participated in the development of a regional grant opportunity with NRRI CARTD, NE Minnesota Higher Education District, MN Department of Employment and Economic Development Workforce Section, and the Northspan Group. The grant is one of the first developed across three federal agencies in order to promote education, research and small business development as way to grow a regional economy.

NRRI Public Relations

PUBLIC RELATIONS ACTIVITIES

Media Progress/Results
Official commercial advertising equivalent of $157,488.83 (-$31,917.64 from last report)

Print Newspaper mentions/stories: 72
- Duluth News Tribune 16
- Minneapolis Star Tribune 1
- St. Paul Pioneer Press 1
- Small towns/Weeklies 54

Web mentions/stories: 24
Television broadcasts: 6 (2 in metro area)
Radio broadcast: 5

Industry trade journals: 3

Social Media
- Facebook (8/22) 42 Likes (People who are fans of the NRRI page)
  50 Monthly Active Users (People who have interacted with the page)
  2,262 Post Views (Number of times people have viewed a News Feed story posted on the NRRI page)
- LinkedIn (8/22) 32 members of the NRRI Group
  12 page views (June 2011)
  6 unique visitors (June 2011)

Print NRRI Now Newsletter: 2,216 subscribers
Electronic Now Newsletter: 366 active contacts
40% Open Rate (Industry Avg. = 20%)

NRRI Website: 20,368 Avg. successful page requests per day (+11,355 from previous report)
Activity for requested reports:
- Economic Geology Group = 48%
- Great Lakes Worm Watch = 7.43%
- Canada Lynx = 9.93%
- Moose in Minnesota = 6%
- CARTD = 5.89%
- NRRI Now Newsletters = 5.89%

Visibility/Other PR Projects

Tours: 116 people (including Senator Roger Reinert)

Other Public Relations Promotions:
- PR staff gave a presentation about NRRI to the Hermantown Chamber of Commerce
- PR staff developed and staffed displays at four events:
  - Duluth & St. Louis County Days at the State Capitol (February)
  - UMD Sustainability Fair (April)
  - Duluth Chamber of Commerce Showcase (May)
  - Watershed Festival (June)