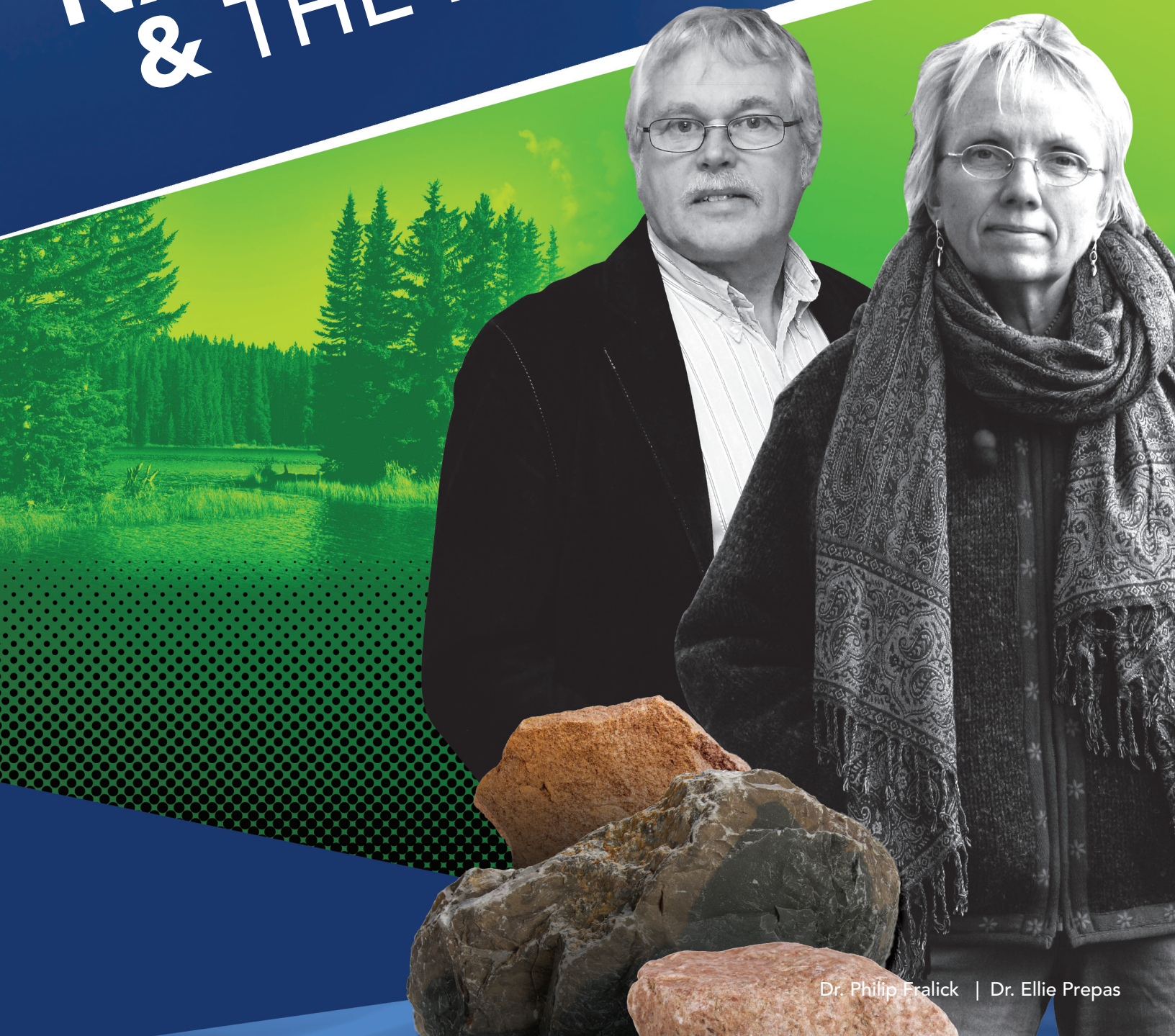
Lakehead
UNIVERSITY

RESEARCH & INNOVATION

NATURAL RESOURCES & THE ENVIRONMENT



Dr. Philip Fralick | Dr. Ellie Prepas

Cutting-edge laboratories coupled with unparalleled opportunities for field research make Lakehead an ideal catalyst for local and regional economic development.

CREATING THE FUTURE NOW

Situated on the shores of the world's largest freshwater lake, in the midst of the boreal forest, at the nexus of resource-based economies and ancient Aboriginal homelands, Lakehead researchers, including three Canada Research Chairs (CRCs) in the field, are working on a range of innovative, interdisciplinary projects. These projects help industry, government, and communities make informed choices about the development of our forests, watersheds, and mineral and metals deposits. Biologist Dr. Greg Pyle, for example, is studying the effects of pollution on the ability of freshwater animals to communicate with each other. Forest hydrologists like Dr. Ellie Prepas, CRC in Sustainable Water Management and the Boreal Forest, are guiding government and industry in the long-term management of our natural resources. Dr. David Greenwood, CRC in Environmental Education, is developing influential pedagogies and models for teaching and understanding "place."

Lakehead's family of cutting-edge laboratories offers sophisticated research facilities for our scientists and industry, as well as hands-on training for students. Twelve graduate programs, including new PhD programs in Biotechnology and Chemistry & Material Science and the University's Biorefining Research Initiative, keep Lakehead at the cutting edge of research into issues of environmental and resource-based development. Strong partnerships with industry and government agencies enhance the value and relevance of that research.

FORWARD-THINKING **watershed management**

"The boreal forest is, quite frankly, an industrial landscape," says Lakehead University natural resources professor Dr. Ellie Prepas. Industry working in a natural environment, she says, requires science-based management and planning processes to stay competitive, successful, and sustainable. "We need to know how much water we can use — and the outcomes of that use — to be able to enjoy the benefits of the water resources in the forest environment."

Since 2001, Dr. Prepas, Canada Research Chair in Sustainable Water Management and the Boreal Forest, has been leading the Forest Watershed and Riparian Disturbance (FORWARD) project. Working in two major geographical landscapes — the Swan Hills, Alberta, and the Legacy Forest of Northwestern Ontario — the FORWARD team collects a vast amount of data from the atmosphere, streams, wetlands, soils, and vegetation, as well as from key indicator species (such as frogs and toads).

The FORWARD database provides researchers, federal and provincial policymakers, First Nations, and industry partners with up-to-date information to analyze and assess the impacts of timber harvesting and natural disturbances like wildfires on boreal water resources. That way, says Dr. Prepas, they can create harvesting plans with scientific knowledge of the projected impact on the water quantity and quality draining from the watershed. "Rather than adopting a 'use now/consider later' approach, it provides the information to create a long-term plan. And that's the only way the water environment can be managed."

FORWARD includes research partners at the universities of Alberta and Saskatchewan, and is funded by the Natural Sciences and Engineering Research Council of Canada (NSERC), the Canada Foundation for Innovation (CFI), the Ontario Innovation Trust, the Ontario Research Fund, the Forest Resource Improvement Association of Alberta, the Living Legacy Research Program, and major industry partner Millar Western Forest Products Ltd., together with an additional nine industry partners. The FORWARD research-industry collaboration was nationally recognized in 2004 with the prestigious NSERC Synergy Award for Innovation.

Dr. Ellie Prepas
Faculty of Natural Resources Management, Canada Research Chair in Sustainable Water Management and the Boreal Forest

LAKEHEAD UNIVERSITY IS AT THE FOREFRONT OF RESEARCH AND INNOVATION IN THE STEWARDSHIP AND DEVELOPMENT OF OUR ENVIRONMENTAL RESOURCES

— LAKEHEAD IS LEADING THE WAY

LIFE **on mars?**

Sometime in the next decade, an unmanned probe will be launched by NASA on a return mission to Mars. It will bring back samples of soil, rock, and other geological debris from the Martian surface in an effort to detect the presence of past or present life.

But what counts as evidence of life? That's the question that Lakehead geology professor Dr. Philip Fralick, a world leader in the field of ancient microbial life, is helping to answer.

Dr. Fralick, the Lakehead University Research Chair on Martian Astrobiology, studies the chemical "biosignatures" left behind by ancient bacteria on Earth, with the idea of figuring out what to look for on the red planet. "If we know what chemical derivatives can be produced only by living matter — and if we can find the derivatives on Mars — then we will know that there had to have been life on that planet," he explains.

Lakehead and the surrounding areas are the perfect backdrop to Dr. Fralick's work. The 1.8 billion-year-old sedimentary rock underlying Thunder Bay contains the fossilized remnants of an ancient and diverse community of bacteria, as well as a layer of debris from a colossal meteorite impact near what is now Sudbury, 1,850 million years ago. Recently, Prof. John Grotzinger, chief scientist of the next NASA Mars mission, and Dr. Fralick compared this layer with the so-called "blueberries" that litter the Martian landscape, showing they are likely not the result of a meteoric impact.

"If we do find good solid evidence of life on Mars, it will probably be the biggest scientific finding of the last 50 or 70 years," says Dr. Fralick. "It will be something that most of us will have to incorporate into our belief systems."

Dr. Philip Fralick
Department of Geology

TESTING **without animals**

Like the proverbial canary in the coal mine, the fathead minnow is a "model species" – often used in experiments to predict how toxins in the environment affect the health of other animals in our waterways.

But testing using the minnows is an expensive, cumbersome process. It takes six months for the little fish to develop from egg to adult, and even longer to test whether pollutants have affected its ability to reproduce. And, ironically, the minnows are sacrificed in experiments to assess their health.

Dr. David Law, an associate professor in Lakehead's biology department, is developing a better way. With Dr. Lucy Lee at Wilfrid Laurier University, he is culturing the liver cells of fathead minnows. The team's goal is to use the cell cultures — which should be as sensitive as the live animal's cells to toxins — to create a water-testing mechanism that is faster, cheaper, and more accurate, not to mention more animal friendly.

"We'd like to give Canadian primary industries that generate wastewater the tools to make sure that they can be good environmental stewards by monitoring the quality of the water they're putting back into the environment."

The project is part of a larger research effort aimed at studying the minnows' gene expression to identify genes that are affected by exposure to chemical effluents in wastewater. Much of the work, which is showing promising results, is being done at Lakehead's Molecular Environmental and Developmental Biology Lab, where Dr. Law is principal investigator.

Dr. Law's project is supported by the Natural Sciences and Engineering Research Council of Canada (NSERC) and Abitibi-Bowater.

Dr. David Law
Department of Biology

THE FUTURE **of our forests**

When most of us look out onto the boreal forest, we see poplar and spruce, jack pine, and trembling aspen. Dr. Han Chen, on the other hand, sees questions.

How, for example, have different tree species responded to global climate change? How do natural disturbances, like forest fires or insect infestation, differ from human disturbances, like logging? Are old-growth forests a carbon source or a carbon sink? How do certain tree species compete with and complement each other for the best yields and other ecosystem functions?

The questions aren't idle: the boreal forest makes up 77% of Canada's forest landscape and covers nearly 60% of the country. "It plays a critical role not only in Canada but on the world stage in terms of mitigating climate change," says Dr. Chen, a full professor in Lakehead's Faculty of Natural Resources Management. "And, of course, it is a critical Canadian ecological and economic driver."

Dr. Chen is studying the impact of ongoing climate change, plant interaction, and natural and human disturbances on the boreal forest system and how that system will respond in the future in terms of ecological function and biodiversity. "If we can predict possibilities for future change, we can allow forest managers and policymakers to make more informed decisions."

Being at Lakehead University, says Dr. Chen, puts him in the centre of a network of industrial, environmental, and government forestry professionals, which fosters collaborative research and relationships in the field. The University's location and strong forestry program, he notes, attracts top-notch graduate students; several of Dr. Chen's students have gone on to highly prestigious research roles. Dr. Chen was a recipient of a Ministry of Research and Innovation Early Researcher Award in 2008.

Dr. Chen's research has been funded by the Natural Sciences and Engineering Research Council of Canada (NSERC), the Sustainable Forest Management Network of the Networks of Centres of Excellence and the Northern Ontario Heritage Fund Corporation .

Dr. Han Chen
Faculty of Natural Resources Management

MINING **for heat**

There's treasure hidden in the landscapes of Northwestern Ontario, ranked one of the world's leading producers of metal and major mineral deposits. But for Lakehead University's Dr. Basel Ismail and Dr. Eltayeb Mohamedelhassan, the ground is a source of a different kind of treasure: renewable energy.

Dr. Ismail, an associate professor in the Department of Mechanical Engineering, specializes in renewable and alternative energy conversion engineering technologies. Dr. Mohamedelhassan, an associate professor in the Department of Civil Engineering, specializes in geotechnical engineering. The two recently combined forces in a project to assess the feasibility of providing cleaner, greener energy sources — through geothermal technology — to the energy-intensive mining industry.

"Mining facilities in Northern Ontario typically operate in harsh, remote environments," explains Dr. Ismail. "To heat their facilities, they conventionally use natural gas–fired or electric heaters, which are very expensive and have a large carbon footprint." Geothermal technology, on the other hand, utilizes the natural heat energy of the ground, making it a much cleaner, renewable source of energy.

Working with the Musselwhite gold mine, approximately 470 km north of Thunder Bay, Drs. Ismail and Mohamedelhassan's team installed geothermal and micro-weather logging stations on the mine site and gathered extensive, real-time data to create profiles of ground temperature and structure. With that data, they determined the optimal design of a geothermal heat pump and exchanger for the mine's residential complexes network. Further, the researchers conducted an innovative experiment that suggests that solar energy could play a supporting role.

This joint research project was supported by Goldcorp Canada Ltd.- Musselwhite Mine.

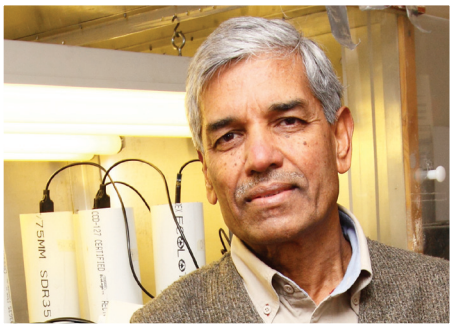
Dr. Basel Ismail
Department of Mechanical Engineering

Dr. Eltayeb Mohamedelhassan
Department of Civil Engineering

FINDING GOLD **in blueberries**

Blueberries are golden: in 2007, they accounted for nearly three quarters of Canadian fruit exports, valued at $441 million.

Lakehead University Biology Professor Dr. Azim Mallik is studying several different types of blueberries in Northwestern Ontario in order to learn more about how the antioxidant-rich fruit develops, and to assess whether different strains can be successfully introduced into the commercial Canadian berry cultivation industry.

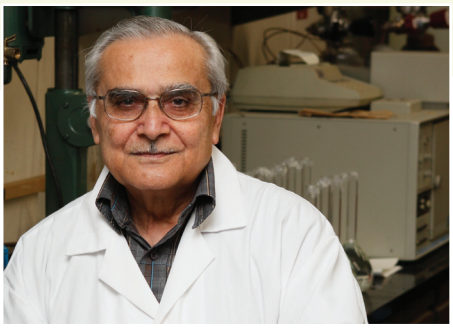


The research team hopes that the project will result in distributing high-quality blueberry clones to Canadian farmers, creating jobs and enhancing the productivity of underutilized farmland — with the longer-term benefit of enhancing the genetic diversity of commercial blueberry strains. Lakehead Social Work Professor Dr. Connie Nelson, a co-investigator in the project, will conduct the social aspect of the study.

This project builds on Dr. Mallik's long-term research in disturbance ecology with special reference to ericaceous plants. In 2006, he was named one of Lakehead University's 40 "Research Stars." He has received the University's Distinguished Researcher Award, as well as the International Allelopathy Society's Grodzinski Award for outstanding research on disturbance ecology and allelopathy (chemical interactions among plants).

Dr. Malik's project is supported by the Ontario Ministry of Agriculture, Food & Rural Affairs (OMAFRA), Northwestern Ontario Bio-economy Corporation (NOBEC), Mountain Fresh Farm, Lakehead University Food Security Research Network, and the Thunder Bay Agricultural Research Station.

Dr. Azim Mallik
Department of Biology



EFFICIENT, ECONOMICAL **environmentally friendly**

Faster, higher … cleaner.

It may not have quite the same ring as the Games' slogan, but when it comes to contributions to the mineral processing industry and the environment, Dr. Inderjit Nirdosh's research is shaping up to be Olympic in proportion.

Dr. Nirdosh, a full professor in Lakehead University's Department of Chemical Engineering, has with his research partners developed a unique family of chemical compounds, arylhydroxamic acids, that could substantially improve efficiencies and reduce waste and costs in the separation of zinc mineral, and sphalerite, from their ore by flotation.

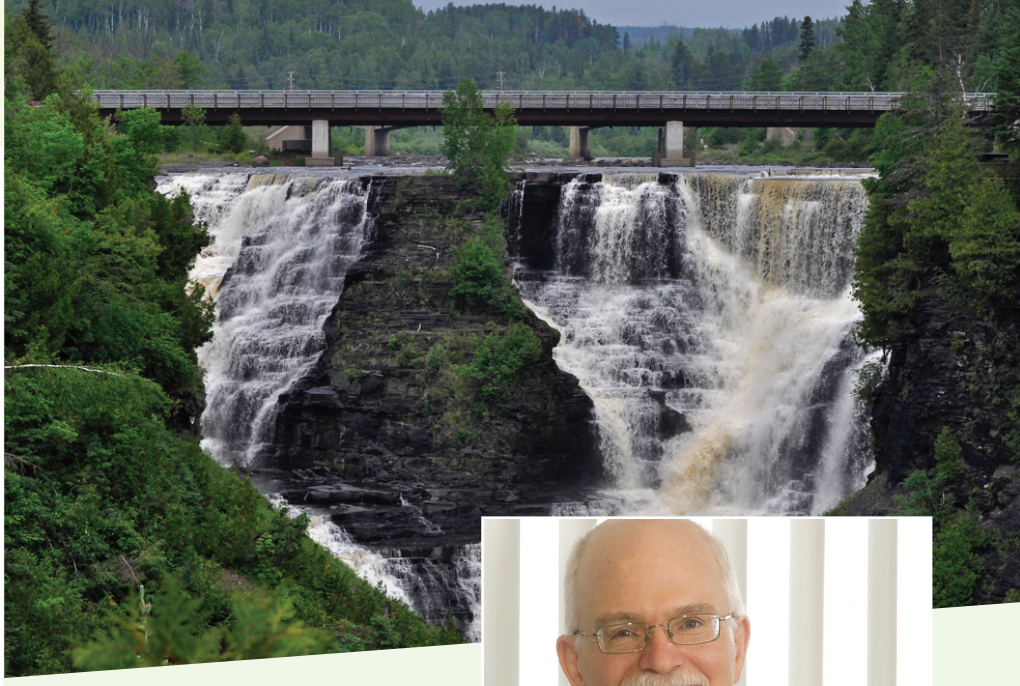
Sphalerite is usually floated using chemicals called xanthates, used in combination with a variety of auxiliary chemicals, in particular copper sulfate. Xanthates, however, says Dr. Nirdosh, don't work particularly well for sphalerite flotation, while copper sulfate — which is the single most expensive chemical in the zinc flotation process — is highly toxic and corrosive.

Arylhydroxamic acids, in contrast, float sphalerite much more efficiently, with much less impact on the environment. In other words, says Dr. Nirdosh, they have faster kinetics, higher mineral recovery rates, and cleaner methods, all of which, combined, will make the metals processing industry economically stronger and environmentally safer. Mills across Canada currently spend approximately $3 million a month on copper sulfate, he points out; switching to arylhydroxamic acids would reduce its use by 90% or eliminate it outright, while also reducing or eliminating the use of a toxic material and reducing corrosion on machinery. What's more, making the switch would not require any costly modifications to current milling machinery.

In short, after some industrial testing of the bench scale results, the commercial production and industry adoption of arylhydroxamic acids would provide huge financial and environmental benefit, says Dr. Nirdosh, who was named one of Lakehead's 40 "Research Stars."

Dr. Nirdosh's research is funded by the Natural Sciences and Engineering Research Council of Canada (NSERC).

Dr. Inderjit Nirdosh
Department of Chemical Engineering



PROTECTING **our water supplies**

Dr. Bruce Kjartanson, an associate professor of civil engineering at Lakehead University, conducts research in the area of geoenvironmental engineering. That field is broad, but so is the scope of the work he takes on.

Currently, for example, he's involved in projects that range from decreasing CO_2 emissions from coal-fired power plants, to reducing groundwater contamination from coal tar released from former coal gasification plants, to the effective management of spent nuclear fuel, to preventing microbes in sewage lagoons from contaminating our water supplies.

What unites these wide-ranging research interests, says Dr. Kjartanson, is an abiding interest in preserving the environment, in particular our water supplies. "I tend to look at the environment as something people need to speak up about and defend," he says. "I want students to understand not just the geoenvironmental aspects, but also the social and environmental impacts of issues."

Take coal-fired power plants. They're the economic lifeblood of many Northern Ontario communities, and their conversion to cleaner fuels is key to community and environmental health. Dr. Kjartanson is working with a group of fourth-year civil engineering students to investigate different alternatives to coal, as well as the assessment of sequestration of CO_2 in deep saline aquifers.

As part of an interdisciplinary team at Lakehead, Dr. Kjartanson recently investigated the efficacy of clay to act as a barrier material in landfills and sewage lagoons. The team discovered that cracks formed in clay materials from exposure to freeze-thaw cycles allow bacteria, like E. coli, to pass through and potentially lead to groundwater contamination. This work can help improve the design of barriers to protect our drinking water.

Dr. Kjartanson's work is funded by the Natural Sciences and Engineering Research Council of Canada (NSERC).

Dr. Bruce Kjartanson
Department of Civil Engineering

CHEMICAL **communications**

Dr. Greg Pyle is trying to decode how freshwater animals communicate with each other — and how human activity interrupts them.

"We think that aquatic animals are using chemical communication to convey an enormous amount of information that is vitally important to their survival," says Dr. Pyle, who holds the Canada Research Chair in Environmental Biotechnology and Ecotoxicology.

Female fathead minnows looking to breed, for example, use their sense of smell to select healthy mates, while tiny water fleas known as Daphnia respond to a predator's scent by developing neck spines that make them too big to be eaten.

Dr. Pyle and his team are trying to determine the effect of pollution on those signals sent by animals, with dramatic results. In lab tests, for example, Daphnia in water containing as little as 5 parts per billion (ppb) of copper developed few, if any, neck spines. Leeches exposed to 10 ppb of copper lost their ability to find food.

"With every metal contaminant that we've tested, with every species that we've tested, we detected significant effects on chemical communication systems," says Dr. Pyle. "And we think it could have a profound effect on the ecosystem."

Dr. Pyle's findings can play an important role in advising governments and industry on the best ways to manage and preserve our freshwater ecosystems.

In addition to Lakehead's robust research infrastructure in terms of laboratory and analytic ability, says Dr. Pyle, the University is ideal for his work because it is home to some of the richest freshwater resources in the world. "Lakehead is situated where biology happens."

Dr. Pyle's research is supported by the Natural Sciences and Engineering Research Council (NSERC), the Canadian Foundation for Innovation (CFI), the Ontario Research Fund (ORF), the Canada Research Chairs program, and Metals in the Human Environment Strategic Network (MITHE-SN).

Dr. Greg Pyle
Department of Biology, Canada Research Chair in Environmental Biotechnology and Ecotoxicology

A BETTER **treasure map**

If mining companies are searching for the Earth's treasures, then Dr. Peter Hollings's research is helping to build a better set of treasure maps.

Working with graduate students at sites as far-flung as Chile, Mexico, and the Philippines, as well as in Northwestern Ontario, Dr. Hollings, a full professor in Lakehead's geology department, is interested in developing our understandings of how deposits of gold, diamonds, copper, and other metals are formed.

For example, he's investigating diamondiferous lamprophyres in the Wawa and Kirkland Lake, Ontario, areas; as their name suggests, these rocks are a source — albeit an unusual one — of diamonds, which usually form in kimberlite. The rocks, which are 2.7 million years old, yield from late Archean period, when a significant proportion of the world's gold resources were formed. "This has implications for many deposit types, including gold, and will help industry make better predictions about where to find resources," says Dr. Hollings.

Dr. Hollings's collaborative, international approach to research has made him a global ambassador for Lakehead University. His efforts have been recognized most notably with the 2008 William Harvey Gross award, presented by the Mineral Deposits Division of the Geological Association of Canada. The award is given to a geoscientist under age 40 who has made a significant contribution to the field of economic geology. As proud as he is to be recognized by his peers, he's even prouder of his graduate students, who have a great track record of working for mining companies on graduation or going on to PhD studies.

Dr. Hollings's research is funded by the Natural Sciences and Engineering Research Council of Canada (NSERC) and a variety of industry partners.

Dr. Peter Hollings
Department of Geology

THE NEW PLACE OF **environmental education**

"You are here." Like a red arrow pointing to a spot on a map, Dr. David Greenwood's research focuses on situating and connecting individuals, communities, histories, cultures, and ecosystems within the context of their specific "places."

As Canada Research Chair in Environmental Education, Dr. Greenwood, an associate professor in the Faculty of Education, has long been interested in the applicability of "place studies" to environmental education. The intersection of the fields, he says, invites broad questions: "What is education for in the 21st century, when we have recognized some of the social and ecological consequences of human activity on the planet? What kind of environmental education ought we to be thinking about given our impact as a species and diverse cultures on one another and the ecosystem? And how do we as educators respond to that complexity?"

That response might mean working with history teachers to integrate community history into the curriculum, getting high school students to contribute to a local urban renewal grant, or taking a university geography class to a local farmers' market and organic garden — these kinds of experiences, says Dr. Greenwood, "have a lot of transformative and pedagogical power."

Dr. Greenwood is leading the inter-faculty development of a new Centre for Environmental, Sustainability, and Place Studies, which will be housed in a new Environmental Education Research Lab at Lakehead University. The Centre, he says, will create and support interdisciplinary environmental research, education, and outreach. Among its many activities will be developing programs and lines of inquiry aimed at "greening" schools and universities, and establishing an international research group to coordinate philosophical and empirical research on place at multiple sites.

Dr. Greenwood's research is supported by the Social Sciences and Humanities Research Council of Canada (SSHRC).

Dr. David Greenwood
Faculty of Education, Canada Research Chair in Environmental Education

THE SECRET LIFE **of trees**

Trees live by a — mostly unwritten — set of rules and codes. Dr. Nancy Luckai and her colleagues are working towards uncovering the secret lives of trees, in order to create more sustainable, intelligent, and profitable ways of managing our forests.

As Dr. Luckai points out, the evidence underlying some management practices in the boreal forest is often based on species or systems that have little in common with those in Northwestern Ontario. That means that managers of the forest are working with scientifically untested assumptions. "There are many theories about how competition works in the boreal forest, but little empirical evidence," says Dr. Luckai, an associate professor of forest ecology in Lakehead's Faculty of Natural Resources Management.

Dr. Luckai's team set out to get a better understanding of ground rules for the boreal forest using a range of innovative strategies. For example, one of her graduate students used DNA analysis of plant roots to ascertain the effect of competition on how far a tree will send out its roots in search of water and nutrients. Another student is examining how poplar and raspberry "compete" in order to determine the ideal proportions to both control the competitors and provide benefits for the crop trees.

In another project, Dr. Luckai is part of a team assessing the viability of converting coal-burning plants to biomass. Working with industry partners like Ontario Power Generation and Abitibi-Bowater, she is determining whether the waste products of biomass burning can be used to sequester carbon, thus reducing the carbon footprint of the process, diverting waste from landfill, and potentially developing a new revenue stream. "A fairly simple technology could potentially have a major impact," she says.

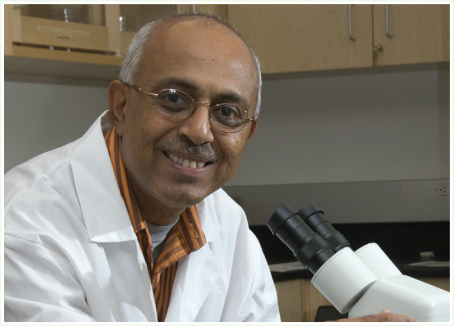
Dr. Luckai's work is funded by the Natural Sciences and Engineering Research Council of Canada (NSERC).

Dr. Nancy Luckai
Faculty of Natural Resources Management

UNDERSTANDING AND **protecting our watersheds**

Wetlands are natural "kidneys" for our watersheds, filtering contaminants and excessive nutrients from the water. They help control flooding, protect our shorelines from erosion, and play a pivotal role in reducing global warming by acting as carbon sinks.

And yet, more than two thirds of Ontario wetlands have been lost or damaged due to agricultural, urban, and industrial land use. In Ontario, Lake Simcoe's water quality — and its cold-water fisheries — have deteriorated markedly over the past half-century.



Dr. Nandakumar Kanavillil, an associate professor of biology at Lakehead University's Orillia campus, is leading a team studying the role of wetlands in the Lake Simcoe watershed. By sampling water before, during, and after it passes through two major wetlands, the team is generating a wealth of empirical data on the extent to which these ecosystems clean up the water. The project is funded by Environment Canada's Lake Simcoe Clean-Up Fund.

As well, researchers Dr. Sreekumari Kurissery and Dr. Peter Lee are seeding selected areas with wild rice to study the plants' potential role in removing phosphorus from the water. The preliminary results, says Dr. Kanavillil, are "very exciting: we're observing a significant reduction not only of phosphorus but other metals and pollutants."

The project, which is the first collaboration between Lakehead's two campuses, builds on Dr. Kanavillil's extensive research background in aquatic ecology. His work on invasive species with Dr. Hugh McIsaac in the Great Lakes helped Transport Canada develop and pass legislation in 2006 that requires all incoming vessels to the Great Lakes to flush at sea.

Lakehead's research-intense, collaborative culture, coupled with its accredited water-quality laboratory facilities, says Dr. Kanavillil, make it an ideal place for him to do his research. "The opportunity to build and develop the research facilities at the Orillia campus is highly satisfying."

Dr. Nandakumar Kanavillil
Department of Biology

LAKEHEAD UNIVERSITY'S **centres of excellence**

Biorefining Research Initiative (BRI)

The goal of the BRI is to create a centre of excellence dedicated to developing transformative technologies and products based upon biomass from the Boreal Forest. The vision of the Biorefining Research Initiative is not limited to fuels and forest biomass for bioenergy, but also considers the economic benefits derived from the forest ecosystem. http://lubri.lakeheadu.ca/

Centre for Tourism and Community Development Research (CTCDR)

The mission of the Lakehead University CTCDR is to promote balanced sustainable development in cooperation with communities and partners through involvement in interdisciplinary research, community education, and consultancy services. http://ctcdr.lakeheadu.ca/mission/

Lakehead University Centre for Analytical Services (LUCAS)

LUCAS is a cornerstone for research and industry, and environmental and resource-based development. LUCAS labs provide researchers with access to the sophisticated equipment they need, as well as hands-on training to the University's best and brightest students early in their careers. LUCAS labs' experienced technical staff, internationally recognized researchers, and unique technology offer a wide range advanced, accredited testing services to local, national, and international clients. The following LUCAS laboratories are currently working in the areas of natural resources and the environment:

- Aquatic Toxicology Research Centre (ATRC)
- Environmental Laboratory (LUEL)
- Forest Resources and Soils Testing Laboratory (FoResT)
- Instrumentation Laboratory (LUIL)
- LEVTEK – Pulp & Paper, Energy Testing
- Material Characterization Services
- Mineralogy & Experimental Laboratory (LUMINX)
- Wood Science Testing Facility (LUWSTF)

www.lucas.lakeheadu.ca

GRADUATE PROGRAMS **in natural resources and the environment**

Faculty of Engineering
- MSc. Eng (Control Engineering)
- MSc. Eng (Electrical and Computer Engineering)
- MSc. Eng (Environmental Engineering)

Faculty of Natural Resources Management:
- MScF (Master of Science in Forestry)
- PhD (Forest Sciences)

Faculty of Science and Environmental Studies
- MSc (Biology)
- MSc (Chemistry)
- MSc (Geology)
- MES (Northern Environment and Cultures)
- PhD (Biotechnology)
- PhD (Chemistry and Materials Science)

Faculty of Social Sciences and Humanities
- MES (Nature-Based Recreation and Tourism)

Research & Innovation | Lakehead UNIVERSITY

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