

ELA UPDATE

Newsletter of the Experimental Lakes Area

Volume X(1) May, 2003

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**Looking Back on 35
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**Research to Protect Fish Habitat
and Lake Ecosystems**

ELA Update

May 2003

As part of our ongoing efforts to keep the interested public informed about our research projects and related activities at the Experimental Lakes Area, we present this newsletter. Also available electronically, this is the tenth year in which one or more such newsletters has been produced and distributed.

The **cover photo** of this edition shows technician Tristan Hodge preparing the apparatus to add small amounts of ethynylestradiol (EE2) to the water of ELA Lake 260.

EE2 is a synthetic estrogen used in birth control pills and for hormone replacement therapy. Even at minuscule concentrations of 6 parts estrogen per trillion parts water, this potent hormone mimic has caused male fish in Lake 260 to produce egg protein, and even rudimentary eggs.

The estrogen additions are continuing in 2003 and researchers will monitor the lake for several years to see if the effects on male fish will result in significant fish population changes over time.

ELA Update is produced by John Shearer, with support from other ELA researchers in the Environmental Science Division of Fisheries and Oceans Canada, Winnipeg. Its production is mandated under the terms of the Canada-Ontario agreement for the ELA.

ELA Fellowship Funds Support Education

With our base of operations at the Freshwater Institute on the campus of the University of Manitoba, the ELA has maintained a long-standing cooperative relationship with the university. Many of our scientists serve as adjunct professors in various academic units. Forty-nine masters and doctoral theses have been completed through work at the ELA by graduate students from the University of Manitoba. Many of these former students are now leaders in aquatic research and education across Canada and around the world.

However, there is a financial cost associated with a student working and living on site at the ELA. Often, students find it difficult to secure enough funding to support their time working on site. During the past decade, two different fellowship funds have been established through the Department of Private Funding at the University of Manitoba to help address this issue.

The first, called the Experimental Lakes Area Graduate Fellowship Fund, is designed to provide on site support at the ELA for current graduate students from the University of Manitoba. Through generous private donations, the principal of this fund has now grown to more than \$400 thousand. Drawing only on the interest produced, the fund annually provides 200 person-days of on-site support plus stipends for selected graduate students, enabling them to focus more effectively on their various field studies at the ELA.

The second fund is called the ELA Undergraduate Fellowship. Established more recently, it is now providing support for tuition and on site research at the ELA to an annually selected University of Manitoba undergraduate student. This student is selected for his/her academic standing and his/her interest in pursuing a career in aquatic science. Over the years, the ELA has hired and trained hundreds of undergraduate students, many of whom have gone on to postgraduate studies and careers in environmental science.

Both of these funds are wholly supported through private donations from interested individuals. One of the key supporters has been Dr. Peter Muller of Switzerland, who spent a year at the ELA in 1977 on a post-doctoral fellowship. Peter now operates a small optical firm, but he has maintained a strong connection with aquatic science and the ELA. He also has a strong environmental ethic and annually donates a substantial portion of his company's profits to support environmental research. Recently, after making a sizable donation to the ELA Graduate Fellowship, Peter was quoted as saying that the year spent at the ELA "changed his life", and that his support of environmental research "is part of a repair cost to nature".

All donations to these funds are greatly appreciated. They are tax deductible and can be made through the Department of Private Funding, University of Manitoba, Winnipeg, MB R3T 2N2.

Experimental Lakes Area Marks 35 Years of Research Success

In the summer of 1968, the Minister of Fisheries for Canada signed parallel agreements with the Dryden Paper Company and the Ontario-Minnesota Pulp and Paper Company, setting aside 46 small lakes and their terrestrial drainage areas for ecosystem-scale research. The focus was eutrophication, the nutrient pollution problem that was destroying the health of the Lake Erie ecosystem. Thus, the Experimental Lakes Area (ELA) officially came into existence.

Over the intervening 35 years, the ELA has become internationally recognized as a unique facility with an impressive record of research achievement. David Schindler, the scientist who directed research at the ELA from 1968 until 1989, has received many awards for his accomplishments and is now recognized as one of the top aquatic scientists in the world.

During the first few years, several small lakes were fertilized with various combinations of phosphorus, nitrogen and carbon. Studies in Lake 227 demonstrated that carbon dioxide from the air could diffuse into lakes, providing sufficient carbon to support algal blooms. Likewise, certain algae can fix nitrogen that diffuses in from the air, thereby making it available for algal growth. This means that phosphorus, not available in the air, is the nutrient most amenable to human control. As the famous experiment in Lake 226 (see

photo, below) so clearly demonstrated, phosphorus is the key to controlling eutrophication problems in most lakes.



A view of divided Lake 226, circa 1973. Both ends of the lake were being fertilized with weekly additions of nitrogen and carbon. The northeast basin (background) was also receiving additions of phosphorus, resulting in the surface algal bloom, so clearly evident.

This experiment was instrumental in convincing authorities to force the removal of phosphorus from many laundry detergents and the addition of tertiary treatment for phosphorus removal in many sewage processing plants. The photos of divided Lake 226 vividly demonstrated the power of doing selected experimental studies in real lake ecosystems.

After such success in demonstrating the importance of phosphorus control for eutrophication, scientists at the ELA shifted their focus to an issue that was, at that time, relatively unknown; namely, acidification of lakes by acidic precipitation ("acid rain").

Beginning in 1976, ELA research-

ers began to gradually acidify Lake 223 using sulphuric acid. By 1981, the pH had been reduced to 5.1 and the small lake trout population in this lake was clearly on the way to extinction, unless the acidification could be reversed. The adult fish were no longer reproducing successfully. Most of their food (minnows, young suckers, crayfish, Mysis shrimp) had disappeared and many of the trout were slowly starving.

At this same time, the Reagan administration in the U.S. was arguing that lake ecosystems were not at risk unless pH values dropped below 5. Clearly, this was not the case in Lake 223, and direct evidence from this real lake study was used to convince authorities in the United States that the acid-causing emissions had to be regulated.

To test the effectiveness of acid reductions, ELA researchers reduced the acid being added to Lake 223, permitting the pH of the lake to rise to 5.4. They observed that naturally occurring bacteria were able to produce enough alkalinity to make the pH rise. No liming was required.

During the 1980s, another acidification experiment in Lake 302 demonstrated that nitric acid (produced by emissions from automobiles) can also be a significant acidifier of lakes. A subsequent study in this lake demonstrated how algae and bacteria living in acidic waters can produce toxins leading to fish



Artificial Reservoirs 2 and 3 of the FLUDEX project, viewed in August 2002. Obviously, the forest has been killed by the flooding. Less obvious are the toxic methyl mercury produced and the greenhouse gases (carbon dioxide and methane) released to the air.

kills. We continue to monitor and document the recovery of this lake ecosystem, demonstrating that even severely acidified lakes are capable of gradual recovery, if acid inputs are curtailed.

While clean air legislation has reduced acid rain in eastern Canada, the reduction has not yet been sufficient to permit the recovery of thousands of acidified lakes.

Since the early 1990s, much of the research at the ELA has focused on the impacts of flooding caused by hydro reservoirs. This work has demonstrated that flooding of soils and vegetation can result in dramatic increases in production of both methyl mercury and greenhouse gases. These increases can persist for years. As a result, Manitoba Hydro is now seeking sites for new projects with a view to minimizing newly flooded areas.

In the past few years, ELA research has diversified to include studies of atmospheric mercury deposition and food web linkages, impacts of hormonal mimics, and cage aquaculture. Given the range of impacts that we

humans are having on our freshwater environment, and the importance of fresh water in our lives, plenty of new challenges lie ahead for this unique research facility that we call the Experimental Lakes Area.

We Can't Do it Alone!

Fisheries and Oceans Canada has many partners for conducting research studies at the ELA. DFO's partners in 2003 include:

*Ont. Ministry of Environment
Ont. Min. of Natural Resources
Environment Canada
University of Alberta
University of Guelph
University of Manitoba
Université de Montréal
University of Ottawa
University of Saskatchewan
University of Toronto
Trent University
University of Waterloo
Hydro-Québec
Manitoba Hydro
Meeker Aquaculture*

*Ontario Aquaculture Association
Tetra Tech Inc.
Flett Research
LimnoTech
U.S. Environ. Protection Agency
Oak Ridge National Laboratory
Nat. Acad. of Science, Maryland
United States Geological Survey
University of Kansas
University of Maryland
University of Wisconsin
American Chemistry Council
Electric Power Research Inst.
Schering Pharmaceutical*



Doug Allan and Ken Mills demonstrate a trap net to participants of the Open House tour. Fish are live-trapped, measured and tagged, then returned to the lake.

ELA Open House a Great Success

Last fall, ELA staff organized a special "open house" event. Through letters and newspaper ads, interested residents of the Kenora area were invited to come to the ELA for a day of tours and demonstrations.

Two buses carrying the tour participants left Kenora at 8:15 on Saturday morning, September 14. During the next eight hours, they had an opportunity to visit several field sites adjacent to the Pine Road, tour the field station, and view demonstrations in some of the laboratories. They also saw a demonstration of live-trapping and tagging fish, which enables us to monitor fish populations without reducing their numbers. The buses then returned to Kenora by 5:30 in the afternoon. A reporter from the Kenora Miner and News was along for the tour and produced a short article for the paper.

Everyone seemed to agree that the event was very worthwhile. As a result, we are hoping to offer a similar event this September for residents of the Dryden-Vermilion Bay area. If you live in this area and are interested in participating, please contact John Shearer at 204-983-5206 or ShearerJ@dfo-mpo.gc.ca. Once the details have been worked out, we will be sending out invitations.

While we have limited resources for organizing and conducting such tours, we do try to accommodate interested groups when possible. Schools or other community organizations are always welcome to inquire about tours.

New Experimental Study Underway

As wild fish populations continue to decline from overharvesting and other environmental stressors, humans increasingly are turning to aquaculture, or "fish farming", to provide a reliable supply of fish for food. Until recently, most of the growth in Canadian aquaculture has been in marine systems on the east and west coasts. However, there now are significant aquaculture operations in some of the Laurentian Great Lakes and freshwater aquaculture is expected to expand in large lakes, and possibly in to smaller inland lakes.

In these operations, thousands of young, hatchery-reared fish are placed in large cages in the open water of lakes and fed food pellets to promote their rapid growth to marketable size. This process can have impacts on the lake ecosystem, some of which are known and some of which may not be understood. Regulators need more controlled studies to better understand these impacts and to help establish scientifically defensible guidelines for regulating this growing industry. What are the impacts of the uneaten food and fish feces that fall through the cage and accumulate on the lake bottom? How do the native fish in the lake respond to the presence of the caged fish? What happens when caged fish escape? How many caged fish are too many for a given lake ecosystem? These and other questions need more definitive answers.

In order to address these questions, researchers, led by Dr. Cheryl Podemski, and in partnership with Meeker Aquaculture and the Ontario Aquaculture Association, are now in the first year of an experimental aquaculture study at the ELA. Five thousand rainbow trout are being raised using standard commercial protocols in a cage in Lake 375. In the fall, they will be commercially marketed by Meeker Aquaculture.

Based on detailed background information from two previous years of study in the natural lake, the resident fish populations and other components of the lake ecosystem are being monitored to determine the nature and magnitude of any impacts attributable to the aquaculture operation. This experiment will continue for at least one more year, but we hope to secure additional funding to extend the research to subsequent years. Stay tuned.

Research '02 Review

Research at the ELA during 2002 continued at a fever pitch, with on-site activities equalling the record levels of 2001.

The largest single project continued to be the Mercury Experiment To Assess Atmospheric Loading In Canada and the United States (METAALICUS). Background studies for a new experiment to investigate impacts of cage aquaculture (see page 5) were responsible for another large chunk of the action. The estrogen addition experiment (see cover photo) continued, as did the upland flooding experiment (FLUDEX), albeit at somewhat reduced activity levels. Monitoring of natural lakes continued. Smaller projects involved recovery from acidification, habitat manipulations, and multi-lake surveys. Here are some highlights.

METAALICUS

During 2002, almost 50 different researchers from more than a dozen organizations worked on this project at the ELA. Mercury is the most widespread contaminant of fish across North America. Much of the funding for this study is coming from the United States, where much of this mercury may originate.

Humans release large quantities of mercury to the air by burning coal and other fossil fuels. It eventually falls back to earth and to water. Carnivorous fish, even in remote lakes, contain high concentrations of toxic methyl mercury. Is there a causal link?

This experiment should tell us. If a direct link can be demonstrated, it may influence regulators to



Justin Shead and Ken Sandilands sample microscopic animals (zooplankton) from Lake 658, the site of the METAALICUS study. The whole ecosystem is being carefully monitored to detect the presence and movement of mercury. (Photo by Karen Scott)

force the removal of mercury at the stack of large power plants, before it is blasted into the air.

In 2002, for the second year, tiny amounts of new mercury were added to Lake 658 and sprayed on the lake's terrestrial and wetland drainage areas. The experiment simulates the additional atmospheric loading of mercury that the lake would experience if it could be moved to New Brunswick for three years.

The new mercury represents only a tiny portion of the mercury already present in the ecosystem. However, it can be distinguished from the other mercury by its atomic weight. Thus, if the researchers begin to detect it in the food web, and particularly in the fish, they know that it is the newly deposited mercury that has been methylated and moved into the food web.

Already, mercury newly added to the lake water has been detected in fish. However, the mercury newly deposited on the forest or on the wetland has not yet been found in the lake's food web. No new mercury has been detected downstream of the study lake.

The experimental additions and monitoring will continue this summer. Additions will be terminated in the fall, but monitoring of mercury in the food web will continue for some time.

Estrogen Study

This fascinating experiment is designed to test whether minute concentrations of a potent mimic for natural estrogen, is able to affect populations of fish and other organisms in a lake by damaging their ability to reproduce.

Last summer, as in 2001, the research team maintained a concentration of ethynylestradiol (EE2) of six parts per trillion parts lake water in ELA Lake 260. EE2 is the synthetic estrogen widely used in birth control pills and for estrogen replacement therapy. While it does break down gradually in lake water, it is not effectively degraded in women's bodies or in most sewage treatment systems. Thus, low concentrations of the substance are continuously being released to lakes and rivers downstream of large urban areas.

Within weeks, this estrogen caused physiological changes in the gonads of fish in Lake 260. Male fish are beginning to produce eggs, a phenomenon also observed elsewhere at contaminated sites. After two years of additions, there is some evidence that minnow populations may already be suffering from impaired reproduction.

The EE2 additions are being repeated in 2003, and researchers will continue to monitor fish populations for several more years to see whether longer-lived species are also suffering population declines.

FLUDEX

This study is investigating how the flooding of upland vegetation and soils can affect production of both toxic methyl mercury and greenhouse gases that contribute to global warming. It attempts to simulate what happens along the edges of large hydro reservoirs that flood boreal forest and forest soils.

Three small reservoirs have been constructed on forested upland sites. For the fourth year, these

reservoirs were continuously flooded from June to October, 2002. While production of both methyl mercury and greenhouse gases continued, the rates of production now seem to be dropping off.

A fifth, and final, season of flooding is getting underway. At the end of this field season, the dikes will be removed and the sites rehabilitated to enable the forest to regenerate. Major funding for this project comes from Hydro Quebec, and particularly from Manitoba Hydro, which is already using knowledge gained to assist in planning for its future projects.

Long-Term Monitoring

Sometimes overlooked, but an increasingly important part of the ELA research program, is the Long-term Ecological Research (LTER) project. It focuses on long-term monitoring of five natural lake ecosystems; namely, Lakes 114, 224, 239, 373, and 442. These lakes have never been experimentally manipulated. The data collected, now spanning up to 34 years, are used to assess natural variability and effects of climatic change, and as references for the experimental studies. These long-term data sets are also prized by many non-ELA researchers because of their unusual detail and length of record.

More Information

More than 40 research projects were carried out at the ELA in 2002. More detailed summaries of ELA research activities in 2002 and previous years are available on line at <http://umanitoba.ca/institutes/fisheries/resact.html>.

Dr. Ken Mills Replaces Dr. Drew Bodaly as ELA Leader

In February of this year, Dr. Drew Bodaly announced that he was stepping down as ELA Section Leader and Scientist-in-charge. During his tenure as leader, Drew maintained an effective balance between administrative tasks and research, while overseeing the two busiest years in the history of the ELA. He now will be focusing on his research activities and has assumed the co-leadership of the large METAALICUS research project. We thank Drew for his major role in ELA success during his tenure as Section Leader and look forward to his continued research contributions.

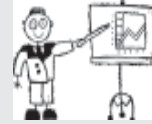
In March, Terry Shortt, Environmental Science Division Manager at the Freshwater Institute announced the appointment of Dr. Ken Mills to the vacant Experimental Lakes Area Section Leader position.

Ken is no stranger to the ELA, having carried out his doctoral research there during the 1970s and serving as an ELA research scientist specializing in fish populations since that time. He will continue to carry on his fish population studies while assuming more of the administrative load.

Before arriving at the ELA in 1973, Ken grew up in Wisconsin and completed a Masters degree at the University of Wisconsin. After 30 years at the ELA, he is on a first name basis with most of the fish.



Community Outreach



Visit the ELA on the Web: umanitoba.ca/institutes/fisheries

Upcoming Events

Following a successful open house event last fall (see page 5), we are planning a similar event for Dryden and Vermilion Bay area residents in September of this year. If you are interested in participating, contact John Shearer (see below, right).

The Lake of the Woods District Property Owners Association is planning a day tour of the ELA for Thursday, July 17. Interested members should contact the Executive Director, Gerry Wilson.

The local membership of the Canadian Institute of Foresters is planning a day tour of the ELA for Friday, June 20.

ELA Tours and Talks over the Past Year

ELA staff operated a display booth at the annual Dryden Home and Sports Show in April 2003. We have been alternating between the Dryden and Kenora shows in recent years.

Students and teachers from Queen Elizabeth High School in Sioux Lookout, Lillian Berg School in Vermilion Bay, and Dryden High School toured the ELA in 2002. Other day tours were provided to OMNR personnel from Dryden and Ignace, and to Junior Rangers from Dryden.

The OMNR Regional Management Team visited the ELA in



Two junior scientists get close-up views of some water "critters", with assistance from ELA biologist Dalila Seckar, at the Dryden Home and Sports Show in April.

October where they hosted a Fisheries Forum and were given a tour of the field station and various field sites.

John Shearer gave an illustrated talk about the ELA to the North-western Ontario Area conference of the Women's Institute, held in Oxdrift last September. John also instructed again at the annual Dryden Conservation Course, and participated in three sustainable forest management workshop sessions sponsored by Weyerhaeuser.

An Electronic Newsletter

With the increasing number of

people who are connected to the Internet, we have made our *ELA Updates* available via electronic means. While we will continue to provide a paper newsletter to those who are not "wired", anyone wishing to assist us in saving paper and postage can receive the same information electronically.

This issue (and previous issues) of *ELA Update* is now available, in colour, in Adobe PDF format on our ELA web site. You must have the free Adobe Acrobat Reader installed on your computer. Just go to the ELA newsletters web page at <http://umanitoba.ca/institutes/fisheries/news-letters.html>, then click on the appropriate hot link.

If you no longer wish to receive the paper version of *ELA Update*, please send an e-mail message to John Shearer (ShearerJ@dfo-mpo.gc.ca) indicating this. You will be removed from our mailing list but can still access the electronic version on the web.

Anyone wishing to learn more about the ELA is invited to contact John Shearer, ELA Operations Manager, 501 University Crescent, Winnipeg, MB R3T 2N6. Phone: 204-983-5206. Fax: 204-984-2404. E-mail: ShearerJ@dfo-mpo.gc.ca