S&E SCIENCE AND THE ENVIRONMENT BULLETIN S&E
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MONITORING THE PULSE OF OUR ECOSYSTEMS

Every day, Canadian ecosystems are exposed to a multitude of human-induced stresses, from harmful pollutants in the air, land and water, to exotic species in our lakes, rivers and forests. Knowing where and how our ecosystems are being affected by these multiple stresses — and what we can do to minimize their impacts on biodiversity and the sustainability of our resource-based economy — is crucial to our well-being.

A student volunteer with the Long Point World Biosphere Reserve — an EMAN site in southern Ontario — cores a tree to determine its age.
Photo: Brian Craig

Changes as subtle as a decrease in the number of frog species in remote lakes or the diversity of lichens on trees can signal potential problems that, left unnoticed, could result in dire consequences. Keeping an ear to the ground for such changes is one of the roles of the Ecological Monitoring and Assessment Network (EMAN), a national alliance of government, academic and private-sector biologists, ecologists, soil scientists, hydrologists, climatologists and citizen volunteers who conduct research and monitor ecosystem change through georeferenced observations — from measuring water levels to counting trees.

Established by Environment Canada in 1994 as a way to further expand mutually beneficial partnerships, EMAN fosters the sharing of information and collaboration among different disciplines and jurisdictions involved in long-term ecological monitoring. More than 140 partners across the country are part of the network, including universities, government departments and agencies, aboriginal groups, non-government organizations, industry, and international institutions.

Although all are independent bodies conducting research and monitoring for their own purposes, their involvement in EMAN means that, where their interests overlap, they piece their findings together to form a bigger picture of what is happening in our ecosystems. The knowledge gained from these cross-disciplinary and cross-jurisdictional collaborations helps determine areas for further research and assessment, and enable Canadians to make more informed choices related to conservation and sustainability of our natural capital.

EMAN's partners work at nearly 100 case study sites across the country. These sites conduct some $20-30 million worth of intensive, long-term research each year, and include Long-Range Transport of Air Pollutant sites for studying acid rain, national parks, UNESCO Biosphere Reserves, and various university and other government research sites. Independent sites within an ecological unit, such as an ecozone based on Canada's Ecological Framework, are encouraged to work together to describe what is happening there and how sustainability might be threatened.

The sites are as diverse as the Canadian landscape. Among them is Kejimkujik National Park in Nova Scotia, where Environment Canada, the Canadian Forest Service, and local universities are monitoring everything from mercury in loons to spruce budworm infestations. At Wolf Creek, in the Yukon, Indian and Northern Affairs Canada, the Department of National Defence, Environment Canada and the International Tundra Experiment are studying watershed hydrology, the seasonal formation and melting of ice, and the growth of tundra vegetation — all of which are excellent indicators of the effects of climate change.

The glue that bonds EMAN is the network's coordinating office at the Canada Centre for Inland Waters (CCIW) in Burlington, Ontario, and Environment Canada's regional leaders who help maintain contact with partners through ongoing communications, site visits and special events, such as workshops. The office keeps tabs on who is monitoring what and where, and links sites and partners so they can more easily share and

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discuss information on issues of common concern. It also develops techniques and products, such as metadata systems, monitoring protocols or web-based communications, that serve the common interests of all EMAN partners.

Where an issue is of particular relevance to both Environment Canada and one or more of its partners, the office may suggest that a report be undertaken. For example, in 1999, six EMAN Biosphere Reserves produced reports on landscape changes over the past 300 years. In addition to assessing data from their ongoing vegetation monitoring efforts — which involve counting tree species, diameters and heights in one-hectare plots — these sites pulled together information from historic land surveys, aerial maps and other sources.

The resulting report, which was presented at a recent UNESCO Biosphere Reserve meeting, provided local insights into processes that merit community attention and an adaptable approach to identifying threats to sustainability. Some of this information has already been used to assess the impact of, and recovery from, the ice storm that hit eastern Ontario and western Quebec in 1998. A similar initiative is under consideration this year to collate information on changes in nearshore marine areas of Canada in order to identify concerns, monitoring approaches and hotspots where biodiversity is threatened.

The latest dimension in EMAN's work has been the development of core variables to serve as the basis for an early warning system of ecosystem change. The variables, still under development, are based mostly on phenomena and species that are sensitive to environmental change and relatively easy to monitor, such as tree health, frog populations, and water levels. Although some groups already keep track of changes in some of these variables, the intent is to engage partners in each of Canada's ecozones in using them, so that standardized comparisons can be made. The EMAN coordinating office is currently finalizing a methods manual for monitoring the variables in the field, and trying to determine how best to implement them. Plans are to involve sites, parks, and environmental monitoring networks, and to adapt the variables to local monitoring needs, so that partners will also derive clear benefits from using them.

In a new initiative which could begin as early as this year, the office plans to begin producing EMAN advisories in collaboration with its partners. These would be short papers summarizing the most current results of ecosystem monitoring or science, so that decision-makers and resource managers can be given early warnings of issues that merit additional attention. The determination of ecosystem changes can take 10-15 years to reach a level of statistical certainty. The advisories would be an important vehicle for bringing information forward early, based clearly on risk and best expert opinion, and would help to better fulfill the needs of responsive priority setting and adaptive management.

The EMAN coordinating office at CCIW also provides support to EMAN partners. It was instrumental in developing the Ontario Forest Data Cooperative web site, which maps data on forest composition, soil chemistry, species biodiversity and other parameters collected by Environment Canada, the Canadian Forest Service, and the Ontario ministries of Natural Resources and the Environment. The office is currently working to develop an interactive web site database of ecological monitoring activities in Canada that will allow users to search using a number of different fields, and view the results as listings of data sources or as a geospatial map.

In recent years, EMAN has expanded its network to include citizen volunteers who are trained to make simple observations by following standard protocols. These observations are focused on indicators that are sensitive to environmental stresses — such as the diversity of plants and animals. The data generated by these important volunteer efforts provide information to Environment Canada on ecosystem changes at a national or ecozone scale and to communities on what is happening locally. The volunteers are

The health of frogs, such as this Gray Treefrog, is a good indicator of the quality of freshwater and wetland habitats. Photo: Niagara Escarpment Commission

taught to identify species by sight or by call, and to submit geographically referenced counts by phone, mail or by logging onto a centralized web site. EMAN is working in partnership with the Canadian Nature Federation to promote the expansion of a variety of local or regional observation programs, such as Frogwatch, Plantwatch and Wormwatch, across Canada. It is also involved in initiating new ones, such as the Icewatch and Lichenwatch programs.

This fall, the network will assist in the launch of the Thousand Eyes project, in which children in schools across Nova Scotia will begin making observations pertaining to the arrival of spring — ranging from the appearance of the Spring Peeper (a frog), to the blooming of flowers and the timing of various agricultural chores. The 20-year project will mirror a similar effort that took place in the province from 1900 to 1920 in the hopes that comparisons between the old and new data will reveal trends about how our climate is changing.

As environmental issues become more complex, interconnected and far-reaching, monitoring the health of our ecosystems requires an increasingly holistic approach that considers the impacts of human activity on every aspect of the natural world — regardless of disciplinary or jurisdictional boundaries. By encouraging scientists of different disciplines to share and discuss their research findings, and engaging citizen volunteers in the collection of data, EMAN is keeping its finger on the pulse of our environment. For more information on the important work being done by EMAN, please visit its web site at [www.cciw.ca/eman/intro.html]. **S&E**

AQUACULTURE AND PESTICIDES

You may not realize it, but there's a good chance that the salmon sizzling on your barbecue wasn't raised in the wild, but in a sprawling net pen off the Atlantic or Pacific coast — gill-to-gill with up to 15 000 other cage mates destined for the dinner table. Over the past decade, fish farming has become big business in Canada — so big, in fact, that salmon have leap-frogged potatoes as New Brunswick's main crop.

Like any farm, these high-density pens are vulnerable to pests, and with salmon those pests include sea lice. These voracious, shrimp-like crustaceans feed on the surface of the fish, decreasing their commercial value and, in some cases, killing them. In 1995 alone, sea lice infestations cost salmon farmers in Atlantic Canada more than $20 million in lost revenue.

To control these infestations, many farmers turn to pesticides, which they apply by enclosing the pens with giant tarps, adding the pesticide solution, and then releasing it to the surrounding environment after the fish have bathed in it for an hour or so. There are concerns that such releases pose a potential risk to non-target aquatic organisms — particularly crustaceans, such as lobsters and shrimp, which are close relatives of sea lice.

In 1996, reports of a major die-off in a New Brunswick lobster pound showed the presence of cypermethrin — a synthetic pesticide authorized for use in the United States and a number of other countries, but not in Canada. Spurred by the incident, and by a growing industry push to register cypermethrin in Canada, toxicology and pollution prevention experts from Environment Canada's Atlantic Region worked with the Department of Fisheries and Oceans to measure the fate and toxicity of pesticides in simulated treatments in the Lower Bay of Fundy, New Brunswick.

Three treatments were done with cypermethrin, and three with azamethiphos — an organophosphorous insecticide that was temporarily registered for use by the federal government's Pest Management Regulatory Agency (PMRA). Dye was added to the pesticide solutions to track their dispersing plumes, and water samples were analyzed for pesticide content and toxicity to a small, bottom-dwelling crustacean related to the lobster.

Dye is added to the pesticide solution in a salmon aquaculture net pen so that when the tarp around the enclosure is removed, scientists will be able to track the dispersing plumes and determine their toxicity.

Most samples taken after the releases of azamethiphos were not toxic to the test organisms in short-term bioassays, and no samples taken at time periods greater than 50 minutes after release were toxic. In contrast, almost all of the samples taken after the release of a single cage treatment of cypermethrin were toxic — even up to five hours after release. The cypermethrin plumes moved distances of up to one kilometre while still above lethal concentrations — indicating that the operational norm of treating multiple cages with the pesticide could have serious area-wide effects on sensitive, non-target species. The studies also showed that cypermethrin contacted the ocean floor in the intertidal zone, where it could have an effect on bottom-dwelling species, particularly crustaceans. Other studies showed that cypermethrin binds to organic matter, which could subsequently be deposited in sediments.

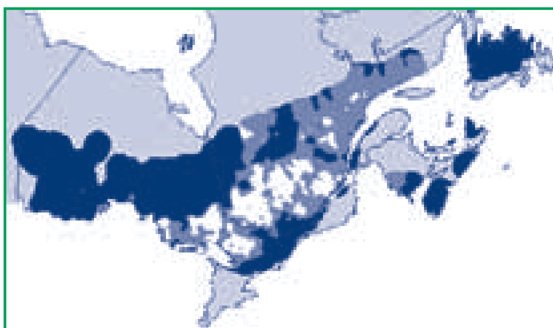
Since the results of the study have been provided to the PMRA, salmon growers, the pesticide manufacturers and local environmental associations, azamethiphos has been fully registered for use in Canada. Cypermethrin use remains illegal, and the effort to register the pesticide has declined. Instead, the salmon farming industry has begun looking at a variety of non-pesticide methods of controlling sea lice — many of which have already proven successful in Europe. These include reducing the number of fish in the pens, separating age classes at each site, leaving the pens fallow for a year, and disturbing the sediment beneath the cages. S&E

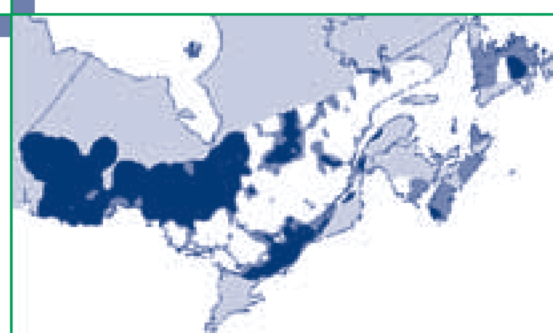
ACID RAIN STILL PLAGUING LAKES AND LOONS

A steady decline in the breeding success of loons over the past decade and the results of ongoing monitoring indicate that, despite progress in reducing sulphur dioxide emissions (SO_2), Canada's lakes continue to suffer from the effects of acid rain.

Sulphur dioxide and nitrogen oxide (NO_x) emitted by metal smelters and the burning of fossil fuels in electrical utilities, factories and motor vehicles are the primary cause of acid rain. When these pollutants come into contact with moisture in the atmosphere, they are converted into dilute solutions of sulphuric acid and nitric acid that fall to the earth as rain, snow, fog and other forms of precipitation.

To meet commitments made under the Canada-U.S. Air Quality Agreement, Canada has reduced its SO_2 emissions by 50 per cent over 1980 levels. This goal was achieved in 1994. The United States is more than halfway to its reduction target, and is expected to meet the 2010 deadline. In contrast, NO_x emissions have remained relatively constant over the past 20 years.





Maps of eastern Canada showing the predicted improvement in the suitability of nesting habitat for fish-eating birds. The lefthand map shows the improvement between 1982 and 2010 as a result of meeting current sulphur emission reduction targets, and the righthand map the improvement if sulphur emissions were reduced by an additional 75 per cent. Dark blue represents no change, medium blue a slight improvement, and white a significant improvement.

Environment Canada scientists have also been studying acid rain for more than two decades, and recent findings indicate that acid levels in our inland waters have responded little to the SO_2 reductions. A study of 152 lakes in southeastern Canada indicates that only 41 per cent are less acidic today than they were 20 years ago, 50 per cent have not changed, and 9 per cent are actually more acidic. Scientists estimate that to protect all of these ecosystems would require reducing SO_2 emissions by 75 per cent over current targets.

Southeastern Canada is particularly vulnerable because it receives more acid rain than any other part of the country and is highly sensitive because of the weak neutralizing ability of the Canadian Shield's granite bedrock. With many lakes and wetlands in the region receiving twice as much sulphate as they can tolerate, models predict that up to one quarter of the lakes in Eastern Canada will remain chemically damaged after 2010.

Loons are an excellent indicator of how lakes are recovering or suffering from acid rain, because acidification causes significant declines in the populations of the fish and invertebrates on which they prey. Lakes with a pH (a measure of acidity) of less than 6 (7 is neutral) support either a different mix or fewer species than those above the threshold. When pH drops to 5 or below, the number of fish species surviving plunges dramatically.

Since two adult loons require up to 180 kilograms of fish during the summer to fledge one chick, breeding success is lower on acid lakes, where young may starve from lack of food. Acid rain also leaches toxic metals, such as mercury, from soil and sediments. These metals can bioaccumulate in the food chain and affect loon reproduction.

For the past 20 years, surveyors with the Canadian Lakes Loon Survey (CLLS) — a volunteer-based program supported by Environment Canada and other partners and administered by Bird Studies Canada — have monitored the breeding success of loons on up to 800 lakes annually across Canada. These surveys have shown that, between 1981 and 1997, the proportion of successfully breeding loons has declined, and that the rate of decline was more extreme

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on lakes with high acid levels than on well-buffered lakes — especially in recent years.

One reason that acid levels remain so high is that there has been a drop in the level of acid-neutralizing bases in the atmosphere — a phenomenon scientists are still trying to understand. The same is happening in forest soils, where decades of acid rain have leached away calcium and magnesium, leaving them less able to neutralize surface water before it reaches lakes and streams.

Another is that hot, dry weather, which is becoming more common due to climate change, converts sulphur that has accumulated in wetlands and soils over past decades into sulphuric acid. When wet weather returns, some of this acid washes into nearby lakes.

Scientists cannot say whether species that have disappeared from an acidified lake will ever return — even if pH levels return to normal. However, near Sudbury, Ontario, where sulphur dioxide emissions from local smelting plants have declined dramatically, invertebrates are reappearing and fish populations are being successfully established naturally or through restocking. Similar effects are being witnessed in Europe, where SO_2 reductions began a decade earlier than in North America.

Restoring lakes damaged by acid rain is a long-term process, but scientists expect that more strict emission-reduction targets will help put these ecosystems on the road to recovery. S&E

Foul Play in the Great Lakes

The past few summers have left a bad taste in the mouths of residents living on the shores of the Great Lakes and St. Lawrence River, where foul smelling, bad-tasting water has increased apprehensions about the safety of local drinking-water supplies. Scientists at Environment Canada's National Water Research Institute (NWRI) have partnered with the Ontario Clean Water Agency (OCWA) to discover what is causing the problem and what they can do to prevent it.

In 1999, the situation lasted a record four weeks. The main source of the taste and odour problems in the water is the naturally occurring compounds geosmin and 2-methylisoborneol (MIB), which can be detected by humans at very low levels. Geosmin and MIB are produced by the bacteria Actinomycetes and some species of blue-green algae, though the exact organisms are not known. Geosmin is thought to originate in the water column and produces an earthy odour, while MIB is produced in the sediment or benthic layer and gives off a musty odour. These compounds resist oxidation and are difficult to remove by standard treatment in water filtration plants.

Over a period of six weeks, NWRI researchers sampled Lake Ontario water near the intakes of two water treatment plants in the Region of Peel at depths varying from 2 to 70 metres from the surface and distances ranging from 0.02 to 10 kilometres from shore. When the samples were analyzed, scientists did not detect MIB, but found concentrations of geosmin ranged from 0.9 to 223 nanograms per litre — higher than any previously recorded. It had been thought that geosmin might originate from decomposing benthic algae near shore; however, samples from the shallowest nearshore site were similar to those from other sites, so there was no support for this theory.

Researchers have come up with several potential solutions as a result of their findings. Over the summer, Lake Ontario stratifies into three thermal zones: a warm upper layer, a transition zone, and a cold bottom layer. They discovered that water extracted from the deepest part of the cold bottom layer contained less geosmin than surface water, leading them to believe it could be possible to avoid the geosmin-tainted water by extending water intake pipes into this layer.

Another option, which is already in use in some areas, is to place granular activated-carbon filters on top of conventional filters in water purification plants. Studies have shown these filters remove an average of 80 per cent of geosmin and 60 per cent of MIB.

In 2000, several regional municipalities, including Peel, Hamilton-Wentworth, Durham, Niagara, York, Toronto and Halton, have joined the taste and odour research consortium and are funding NWRI and the Ontario Ministry of the Environment to continue studying the problem. Scientists will now try to determine exactly which organisms cause the geosmin and 2-methylisoborneol and see if they can be predicted or controlled. They will also expand their research to find out if other factors such as nutrient distribution, algal population levels, and zebra mussels are contributing to the recurring taste and odour problems.

The taste and odour episodes vary from one year to another, therefore the problems cannot be solved rapidly. It is expected that the studies will proceed for several years to account for differences in the weather affecting the biota of the lake. The results of this research will be of value to Ontario municipalities trying to address taste and odour problems.

IN THE THICK OF THE SLICK

When a marine oil spill occurs, some of the oil on the outer edge of the spill disperses, and a certain percentage breaks down and mixes with the water. Depending on the type and quantity of the oil, however, large areas can remain thick and gooey for weeks — posing a threat to wildlife and to nearby shorelines.

Although the colour of an oil slick on water can provide some information about its thickness, it is only recently that an accurate method has been developed for measuring the thickness of a slick on water from the air.

Knowing the exact thickness of a slick helps emergency responders direct their energies to the most hazardous areas of a spill, and enables them to determine the most effective means of cleaning it up. Until now, the only way of obtaining this information for thin slicks was to judge by their colour — a method that is accurate only to within 200 per cent of the actual value. For thicker slicks a variety of sensors, including infrared and microwave techniques, have been tested with little success beyond relative thickness information.

Now, after more than 10 years of research and development, scientists are flight-testing a prototype sensor that can measure the thickness of an oil slick on water from the air. The development of the new technology, known as the Laser Ultrasonic Remote Sensing Oil Thickness (LURSOT) sensor, is a joint project involving Environment Canada, Imperial Oil Resources Limited, the U.S. Minerals Management Service, and the National Research Council.

To determine the thickness of an oil slick, LURSOT measures the time it takes for an acoustic wave to move through the oil. Three different lasers are involved. The first examines the surface of the slick to determine when the target is flat enough for a measurement to be taken. The second fires an infrared beam at the slick, causing the oil near the surface to heat and expand rapidly, and sending an acoustic pulse downward. When the acoustic pulse reaches the water, a portion is reflected back upward, causing another detectable displacement in the surface of the slick. A third laser measures the Doppler shift that occurs when the surface rises — first from the initial expansion, and again when the echo comes back. Since this technique is accurate to within 0.1 per cent and the speed of sound in different oils varies by less than 10 per cent, even the thickness of an unknown oil can be determined with much greater accuracy than before.

In addition to pointing responders to the thickest area of a slick, so it can be remediated promptly and environmental damage minimized, the new sensor will help evaluate the effectiveness of a variety of response techniques — particularly the application of dispersant, which is used to help oil enter the water column and, thereby, reduce impacts on nearby shorelines. It will also ensure that the most effective methods are used for existing conditions. For example, *in situ* burning requires a minimum oil thickness of 2.5-3 mm in order to sustain itself. Most importantly, LURSOT will provide valuable information on oil slick dynamics, so responders will have a better understanding of how these slicks spread.

Since its first airborne tests were conducted seven years ago, the sensor has undergone several improvements, and has been extensively tested in large-scale laboratory experiments. Most of these improvements were aimed at reducing the impact of aircraft vibrations on laser alignment, and included the development of a more sturdy housing structure and the addition of components that are less sensitive to and can actively compensate for vertical movement of the aircraft. If the latest set of flight tests, scheduled to take place by this fall, run smoothly, scientists are hopeful that LURSOT could be operational within a couple of years. S&E

NETWORK PINPOINTS LIGHTNING STRIKES

Few displays of the sheer force of nature are as spectacular and humbling as a bolt of millions of volts of electricity streaking down from the sky in a deafening, hair-raising explosion of thunder. Although lightning strikes the earth 50-100 times every second, its ability to terrify remains justifiably undiminished: in Canada, lightning kills half a dozen people, seriously injures 60-70 others, and ignites some 4 000 forest fires on average each year.

Information on the precise location, strength and timing of lightning is crucial to a wide range of operations that are vulnerable to direct hits or to fluctuations in electric power. By confirming that there is a mature thunderstorm in progress, the presence of lightning assists weather forecasters in issuing warnings to those at risk. For example, the aviation industry relies on such warnings to protect aircraft and ground crew, while forestry and parks services use them to determine areas where lightning-induced fires are most likely to occur, as early detection is critical to saving valuable timber.

A reliance on radar, satellite imagery and ground reports made lightning detection a challenging task, particularly in unpopulated areas, until the Canadian Lightning Detection Network came into being two years ago. Eighty-one sensors across the country, most of them located south of the treeline, form the Canadian half of a North American network that is the largest of its kind in the world, able to process more than 200 000 strikes per hour. The Canadian network not only detects ground strikes, but also is the first national network of its size with the capability to detect cloud-to-cloud lightning.

The cylindrical sensors, which stand over a metre high, determine the strength, polarity and timing of lightning from the electromagnetic pulse it produces. The pulse information is sent via a miniature satellite dish to the network control centre in Tucson, Arizona. There the information from many sensors in the network is integrated to determine the location of the strike, in some areas to within half a kilometre. The lightning location information is then transmitted to Environment Canada's weather centres, where it is mapped on a computer screen in real time. The whole process takes less than 40 seconds from start to finish.

1) Canadian Lightning Detection Network sensors pick up the electromagnetic signal from a lightning stroke, and 2) the signal data are uplinked to a communications satellite, 3) downlinked to the Telesat Hub in Toronto, and then 4) relayed to the Network Control Centre (NCC) in Tucson, where they are integrated with other data. 5) Solutions are relayed from the NCC back to the Telsat Hub in Toronto, 6) uplinked to the satellite, and 7) broadcast to the users' workstations.

In the northern hemisphere, most lightning occurs between June and August. The circumstances that lead up to a strike occur when hail and supercooled water droplets in a cloud collide, causing them to become electrically charged. The positively charged fragments are carried in the wind to the top of the cloud, while the negatively charged pellets collect in the bottom. Eventually, the two areas build up to such a point that a flash of electric current jumps across the gap.

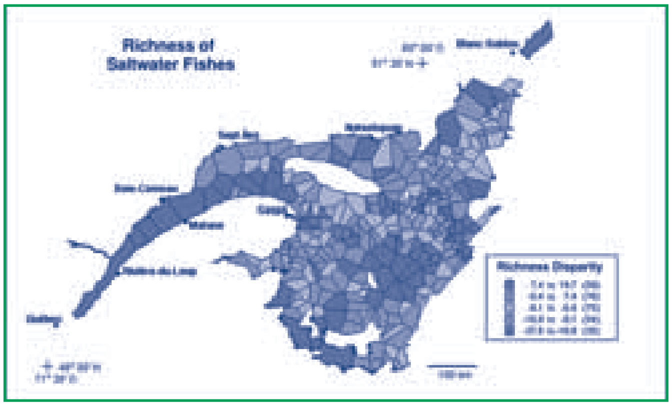
This usually occurs within the cloud, but a third of the time it jumps from cloud to ground, creating an ionized channel. As it approaches the ground, this channel draws a charge of opposite polarity from a tall object on the ground — often a tree or tall building. When the two meet, the pathway is completed, and a spectacular flash of energy is funneled downward in the form of lightning. As the air in the pathway suddenly superheats to 30 000ºC, it produces large sound waves of thunder.

Every strike detected by the network is stored in a data archive, which can be used to produce flash-density maps showing lightning activity in Canada over a certain period of time. Although the network is still too new to identify any long-term trends, scientists are hopeful that these data will help to determine which areas of the country are most or least likely to encounter thunderstorms — and how lightning activity is affected by other weather- and climate-related factors. In the future, more sensors may also be added to locations above the treeline in order to better define lightning activity in more northern remote areas. S&E

EXPLORING THE ST. LAWRENCE ON-LINE

Ever since French explorer Jacques Cartier first followed its sparkling waters into the heartland of the New World four centuries ago, the St. Lawrence River has served as Canada's most important commercial waterway. Over the past 100 years, unprecedented development along its shores and the exploitation of its natural resources have had a profound effect on the river's aquatic and terrestrial ecosystems.

To assess the impact of human activity on these ecosystems — and to protect the estimated 27 000 species of plants and animals that live in them — a team of 40 scientists from Environment Canada and the Quebec Ministry of the Environment have created an Internet atlas of the river's ecology and biology. The team spent five years collecting and analyzing information gleaned from 30 years' worth of scientific papers, surveys, reports and databases, and converting it into mappable data. The purpose of the atlas, created under the Canada–Quebec St. Lawrence Vision 2000 action plan, is to raise awareness of areas where species are particularly vulnerable, and to help identify potential sites for conservation.



A page of the on-line Biodiversity Portrait of the St. Lawrence River, showing the predicted and actual richness of distribution of saltwater fish.

Known as the Biodiversity Portrait of the St. Lawrence River, the atlas covers the Quebec region of the river; that is, the upper two-thirds that runs from Lake St. Francis to the Gulf of St. Lawrence. Users can take a virtual tour of the St. Lawrence by viewing maps, charts and text summaries that describe the region from several different standpoints, including ecological structure, biodiversity, human impacts, and priority conservation areas. The atlas's ecological mapping system divides the river into natural regions and riparian landscapes, and allows users to explore at an even closer range by incorporating a georeferenced grid that breaks each terrestrial region into 100 km^2 parcels.

The ecological structure of the river is described in physical terms, such as climate, land use, vegetation and development for terrestrial ecosystems, and sediment, water depth, hydrography, and salinity for aquatic ecosystems. Data on more than 5 000 species of flora and fauna — including vascular plants, aquatic invertebrates, fish, reptiles, amphibians, birds and mammals — are used to evaluate the biodiversity of the St. Lawrence, and their distribution across the region is mapped.

In addition to identifying locations where human effects are evident — such as areas of chemical contamination, commercial fishing, and places where shorelines are eroding due to shipping traffic or development, or where wetlands have been affected — the accompanying text also analyzes the data and predicts possible future impacts. This information, combined with the data on species biodiversity, is used to determine priority conservation areas based on species richness and vulnerability.

By helping to make the links between human activities, habitat and biodiversity easy to see and understand, the new atlas enables users — from politicians and resource managers to members of the public — to consider the impacts of their decisions on the environment before they act. It will also help scientists develop more effective models for predicting how changes in habitat and human activity affect biodiversity in other ecosystems and regions. The Biodiversity Portrait of the St. Lawrence is on the Internet at [www.qc.ec.gc.ca/faune/biodiv]. S&E

ALL ABOUT S&E Bulletin

This bi-monthly publication is produced by Environment Canada to provide information on leading-edge environmental science and technology to Canadians.

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Media representatives and others interested in conducting further research may obtain contact information from the *Bulletin*'s editor, Paul Hempel, at Paul.Hempel@ec.gc.ca, or (819) 994-7796. Readers' comments and suggestions are also welcome.

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