S&E SCIENCE AND THE ENVIRONMENT BULLETIN S&E
Issue No. 25 July/August 2001

SOWING THE SEEDS OF CHANGE

Over the past century, the cultivation of land for food crops and the introduction of tame forage for cattle production have gradually eaten away most of Canada's native prairie grasslands. This devastating change in habitat has brought about a significant decline in the diversity of plant, animal and insect species and upset the natural balance of life in this delicate ecoregion.

The Last Mountain Lake National Wildlife Area in south-central Saskatchewan encompasses over 15 600 hectares of wildlife habitat. The area is a checkerboard of tracts and patches of introduced, native and intermixed vegetation that is not only difficult to manage, but also threatened by the advancement of exotic species into the remnant native-prairie habitat.

Environment Canada grassland ecologist Dean Nernberg wild harvests seeds from native prairie grasses using a gas-powered stripper.

To heal the broken land and reconnect the natural prairie communities, Environment Canada initiated the Mixed Grass Prairie Habitat Restoration Project in 1992. In less than 10 years, the project has developed effective techniques for wild harvesting, handling, processing, cleaning, storing, and planting over 70 species of native grasses and wildflowers. Since 1994, some 50 hectares of diverse native prairie species have been planted from wild-harvested seed at Last Mountain Lake, the largest restoration project of its kind in Canada.

For the scientists involved in the project, the effort has meant a lot of trial and error, as wild harvesting is a species-specific art. For example, dominant grasses may be present in sufficient quantities for their seeds to be harvested using a mechanical stripper that is similar to that used for most grain crops. However, many native grasses grow in small, scattered clumps, so they must be stripped using a gas-powered stripper that knocks the seed out of the seed heads and blows them into a catch bag. With many wildflowers and other plants that grow near to the ground, the pods or seed heads have to be picked by hand.

The harvested seeds are taken back to Environment Canada's processing and storage facility at Last Mountain Lake—a large building that was dismantled and shipped to the site from Wainright, Alberta, where it served for many years as part of the Department's Peregrine Falcon rearing facility. It is here that the collected seed is cleaned and separated from the chaff—another species-specific process that requires the use of specialized equipment. Old machinery that was once used for agricultural crops is often modified for use in processing wild-harvested seeds, since it is better suited than most modern machinery for handling small quantities. The seeds of some species are threshed with traditional farm equipment or separated with fanning mills and screens. Spear grass, on the other hand, can be harvested mechanically, but sticks together in large and unwieldy wads that have to be fed by pitchfork into a "de-bearder" that breaks the awns off the seed.

The testing and analysis of seed stored over years in this specialized facility and of plants raised in greenhouses and at test sites have yielded much information on the longevity, germination, flowering and seed production of various grass and wildflower species. Through years of observing these plants in the prairie

Continued on page 2

INSIDE

Continued from page 1

ecosystem and in gardens and test sites, scientists also know their soil, water, sunlight and nutrient needs, and how well they fare in competition with other species. The Department's collection of long-term germination and phenological data on over 50 native prairie species is the largest of its kind in North America.

The initial goal of the effort at Last Mountain Lake is not to replace all of the introduced forage with native species, but to enlarge the core area where most of the native grassland is now concentrated and surround it with a buffer zone of non-invasive vegetation—leaving the outer area of the site for hay production, which benefits the surrounding farm community. Local farmers also assist with the project by preparing the restoration sites through standard cropping practices. Farming these sites for three to five years with the required cultivation and selective use of herbicides, ensures that perennial exotics are eliminated or greatly reduced. The farm producers receive the benefit of the crop with no land rental costs, and provide Environment Canada with clean beds for planting.

Once the site is prepared, site staff use a no-till drill with specialized seeding boxes and mechanisms to plant the native seed mixtures. For some species, in particular legumes, the thick coats of the seeds must be scratched or "scarified" before they are planted, or else they may lie dormant for decades. Others take two seasons or more to germinate. During the first growing season, the newly planted fields are very weedy, as native species grow more slowly than introduced species—using 90 per cent or more of their growth the first year to establish roots that will enable them to withstand drought conditions.

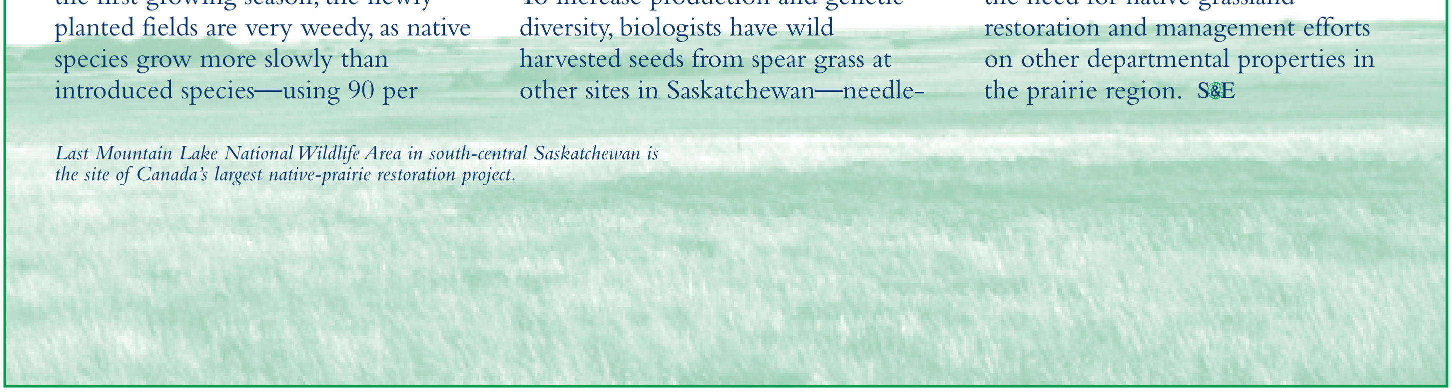
In the second year, however, the native grasses come on strong, and after a second year of mowing (to reduce grass competition with establishing wildflowers) and a few years of growth are sufficiently established to be incorporated into a regular regime of grazing and burning. These management techniques stimulate native plant growth and prevent the invasion of exotic species. Scientists report that the 50 hectares of native prairie species planted at Last Mountain Lake are faring well, despite recent drought conditions, and that slower-growing native wildflowers and legumes have started to take hold.

Environment Canada scientists provide advice on wild harvesting, processing and planting to oil and gas companies, wetland conservation groups, government bodies and many others involved in native vegetation reclamation efforts—both in the prairies and across North America. They also assist reclamation efforts by processing seeds collected by these agencies. The Department's facility is the only one in Canada equipped to efficiently process spear-grass seeds. These seeds are highly sought after because spear grass is dominant in native prairie grasslands and is, therefore, necessary to replicate the natural make-up of these areas in restoration efforts.

To increase production and genetic diversity, biologists have wild harvested seeds from spear grass at other sites in Saskatchewan—needle-and-thread grass from the Prairie National Wildlife Area in the Great Sandhills, and porcupine grass on pasture and private ranchland in the Missouri Coteau. The former is very hard to wild harvest because its seeds ripen and shatter almost as soon as they are exposed to wind, making the window for harvesting very precise.

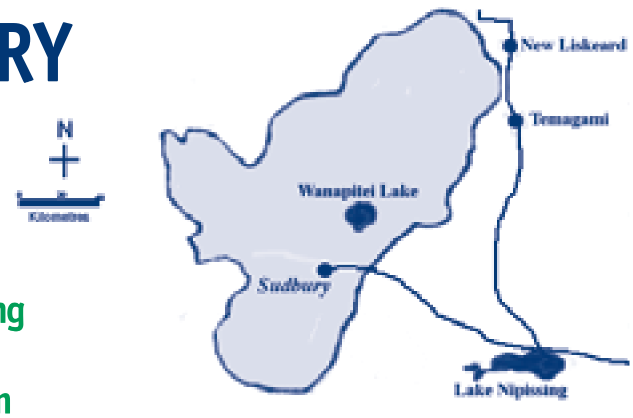
In addition to wild harvesting seeds, scientists have developed a native seed production nursery containing more than 50 species of native wildflowers, as well as a large spear-grass nursery to bolster the availability of this important seed stock—both of which will aid restoration efforts by making seed more readily available and easier to collect. The latter began producing a limited amount of seed for the first time this summer. The nurseries are also used to raise plants in cases where seeds are rare, and for planting in specific areas—such as public gardens and other small sites.

As restoration efforts at Last Mountain Lake progress, scientists will continue to collect data on native prairie plants in the area, with an eye to eventually compiling and analyzing the data so that they can be made more widely accessible to the public and to restoration practitioners. Also on the horizon is the creation of a how-to manual on native harvesting and planting for use by others involved in restoration efforts. Over the next few years, Environment Canada will be using the knowledge and experience it has gained through this project to assess the need for native grassland restoration and management efforts on other departmental properties in the prairie region. S&E



Last Mountain Lake National Wildlife Area in south-central Saskatchewan is the site of Canada's largest native-prairie restoration project.

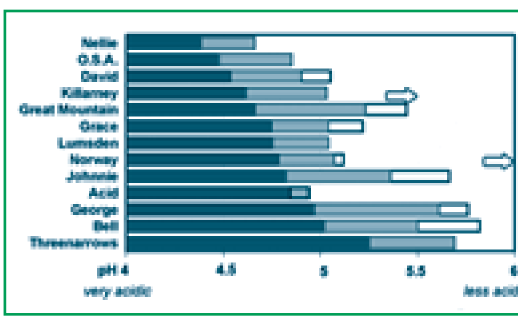
THE WAY BACK: SUDBURY LAKES RECOVERING FROM ACID RAIN



Shaded area indicates approximate location of 17 000 km^2 zone affected by Sudbury smelters. The zone contains over 7 000 lakes that have been acidified to an estimated pH of less than 6.0—the apparent threshold for significant biological damage.

More than a century of metal mining and smelting took a heavy toll on the environment around Sudbury, Ontario. Sulphur dioxide emissions from local smelters acidified an estimated 7 000 lakes in a zone of about 17 000 square kilometres—much of which was previously pristine wilderness.

Pollution control measures applied in the 1970s and 1990s reduced local emissions by about 90 per cent and produced remarkable improvements in the chemistry of some lakes in the area. Others, however, remain severely acidified. Researchers from government, industry, and Laurentian University in Sudbury are working together to learn more about this recovery and to assist in rehabilitating damaged aquatic ecosystems.



Recovery rates of some acid-damaged lakes in Killarney Park. Dark green indicates pH level of lakes in 1980, light green from 1980 to 1993, and white from 1993 to1999. Source: Cooperative Freshwater Ecology Unit, Laurentian University.

Environment Canada's National Water Research Institute (NWRI) is one of the partners in the Aquatic Restoration Group, along with the mining companies Inco Limited and Falconbridge Limited, and the Ontario ministries of the Environment and Natural Resources. Established in 1997 and coordinated by Laurentian's Cooperative Freshwater Ecology Unit, the group is tracking the chemical and biological changes in lakes that have occurred in response to reduced sulphur and metal emissions. It is also exploring links between the acidification recovery process and impacts of other environmental stresses.

Researchers have observed changes in water chemistry, such as increased pH and decreased concentrations of sulphate, base cations (e.g., calcium, sodium, potassium, and magnesium) and aluminum. These improvements in water quality have, in turn, encouraged a biological recovery for several groups of organisms—including phytoplankton, zooplankton and fish—in some of the area's lakes. Scientists worldwide consider the developing recovery of Sudbury's lakes one of the most convincing and best documented case studies of ecosystem responses to reduced acid rain. The studies have also highlighted complicating factors that can impede recovery.

In recent decades, extremely clear acidic lakes in the area have become much clearer, likely due to changes in climate and increased ultraviolet (UV) radiation. Even though they continue their slow recovery from acidification, these clear lakes are more transparent and, therefore, allow the sun's rays to penetrate deeper. Greater exposure to UV radiation from this sunlight is potentially harmful to aquatic species and prevents the restoration of healthy aquatic communities.

Drought, another climatic variation, can also play a role in stalling the recovery process. When a dry period occurs, the sulphur stored in lake catchments and sediments from years of high atmospheric deposition can be released. This can delay recovery or even cause re-acidification of the lake, with serious consequences for the biological revival that is still in its early stages.

The members of the Aquatic Restoration Group are aware that this is a critical time for environmental assessment research in the Sudbury area. Their water quality studies will not only assess the effectiveness of emission reductions to date, but also provide the scientific knowledge on which to base decisions about the need for greater pollution controls. The group has begun new work to identify which components of the ecosystem are capable of unassisted recovery and which require active restoration measures, such as introducing species or modifying habitat. It will also investigate further the role played by the long-range atmospheric transport of pollutants—now thought to be the dominant source of acid input to most Sudbury-area lakes—and continue to explore the impacts of climate fluctuations and the storage of contaminants in watersheds.

An initiative such as the Aquatic Restoration Group is one way to share information and join forces in the fight to promote the recovery of ecosystems from acidification. Although still at an early stage, results in the Sudbury lakes hold promise that similar recoveries from acidification can take place elsewhere in the world. S&E

RESTORING NANAIMO'S SHELLFISH BEDS

For thousands of years, the people of Vancouver Island's Snuneymuxw First Nation relied on fresh seafood from Nanaimo Harbour as a dietary staple and for ceremonial and other traditional purposes. Since 1949, however, the harvesting of shellfish in the harbour has been prohibited due to bacteriological and chemical contamination from forestry, agricultural, industrial and commercial activities along the coastline and upstream on the Nanaimo River.

Despite the fact that it is illegal, some band members have continued harvesting shellfish for their own uses or subsequent sale to other consumers. With single catches of up to 200 kilograms of shellfish possible on a good tide, the potential impact of such activities on the health of First Nations and other consumers is a serious concern. To address the situation, shellfish and aquaculture experts at Environment Canada are working with the Snuneymuxw people and the British Columbia Ministry of the Environment, Lands and Parks to restore water quality in Nanaimo Harbour and reopen its shellfish beds to legal harvesting.

As a key player in the Canadian Shellfish Sanitation Program, Environment Canada is responsible for surveying and classifying the nation's coastal waters to ensure that the waters from which bivalve molluscs such as clams, oysters, mussels and certain species of scallops are harvested, are of acceptable sanitary quality. These filter feeders take in water through their gills and strain out minute particles of food for consumption. As a result, contaminants become concentrated in their tissue and can cause serious illness and disease in those who consume them.

To help determine the sanitary quality of these shellfish-overlying waters, biologists in Environment Canada's Pacific and Yukon Region take approximately 5 000 samples per year and analyze them for fecal coliform bacteria. They also carry out toxicity testing and shoreline assessments to determine if chemical contamination is a concern. Based on their findings, growing waters are classified as approved for direct harvesting, closed (meaning harvesting may take place only under certain conditions and with a special permit), or prohibited completely.

Of the 140 coastal sectors in the region—which encompass 28 000 kilometres of coastline from the border of Alaska to the 49th parallel, from the mainland coast to the west coast of Vancouver Island and the Queen Charlotte Islands—less than 10 per cent are classified as prohibited. Most of these are major harbours, such as Nanaimo, Comox, Victoria, Esquimalt, and Vancouver. A significant amount of pollution in Nanaimo Harbour is fecal contamination that washes off the land as a result of rainfall. However, high levels of chlorinated compounds are found near mills at one end of the harbour, and the waters also receive pollutants that originate upstream of the Nanaimo River estuary.

Nanaimo Harbour and the Nanaimo River estuary on Vancouver Island, British Columbia.

In 1999, the Department entered into a three-year agreement under the Georgia Basin Ecosystem Initiative to work with the First Nations to identify the sources and extent of contamination in Nanaimo Harbour and determine ways to upgrade the classification of the beds. The first phase of the project is aimed at improving water quality in the eastern half of the harbour sufficiently that depuration harvesting will be allowed with a special permit. Depuration is a purification process in which harvested shellfish are put into large holding tanks on land, and cleanse their systems through prolonged contact with continuously flowing clean seawater. If shellfish harvesting in the harbour were reopened, it could represent a million-dollar-a-year industry for the Snuneymuxw First Nations.

Since having been formally trained to monitor water quality in the harbour, the Snuneymuxw have carried out extensive water-quality sampling and shoreline assessments, and mapped their findings on computer. If the agreement is extended, more tests will be conducted to determine bacteriological levels during the wet season, when runoff is at its peak. Biologists are also advising their First Nations partners on how to approach organizations whose activities have been identified as sources of pollution and encourage them to clean up their operations.

This initiative will be given significant exposure at the International Conference on Shellfish Restoration, which will take place in Nanaimo in September 2001. The conference will focus on the theme of using science and community partnership to improve the health of coastal ecosystems through shellfish restoration. S&E

FORECASTS SURGE AHEAD WITH NEW SYSTEM

On January 21, 2000, the most severe storm in 35 years struck the Atlantic coast near Charlottetown, Prince Edward Island (PEI). The low atmospheric pressure in the heart of the blizzard pulled the surface of the ocean upward, while gale-force winds pushed the water in one direction—raising its level 1.5 metres above what was already an unusually high tide. The phenomenon, called a storm surge, flooded coastal areas of PEI and eastern New Brunswick, causing widespread damage to unprotected docks and other shoreline structures.

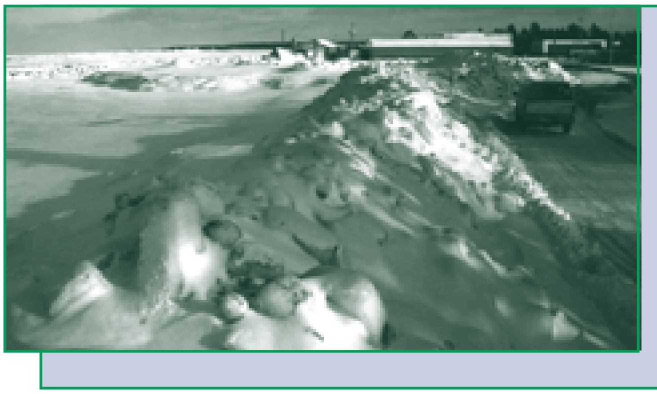
Atlantic Canada averages one or two major storm surges (0.6 metres or more, coinciding with a high tide) a year. Most occur during the winter months, when storms tend to be worse than at other times of the year. Geographical conditions make some areas—including the Gulf of St. Lawrence and the Northumberland Strait—more prone to surges or their effects; however, any exposed coastal shoreline could be affected. This winter, forecasters in the Atlantic Region of Environment Canada's Meteorological Service of Canada (MSC) implemented the nation's first fully operational system for predicting storm surges and determining whether they pose a risk of flooding.

The system has been developed and tested in Halifax in cooperation with the Atlantic Environmental Prediction Research Initiative—a collaborative effort involving MSC's Atmospheric and Climate Science Directorate and the Oceanography Department at Dalhousie University. Researchers at Dalhousie spent more than five years creating a numerical model that predicts surges using data on atmospheric surface pressure and winds on the Atlantic Ocean. The data are provided by MSC's regional weather forecast model, and enable storm-surge forecasts to be made 48 hours in advance.

The system began running in test mode at the Maritimes Weather Centre in Dartmouth, Nova Scotia, in the fall of 1999. Evaluations carried out by comparing predictions with observed storm surges at a variety of sites proved the system quite accurate, and capable of predicting the magnitude of significant surges—including the one on January 21—to within 10 per cent. In December 2000, it was put into full use for daily forecasting in the region.

Forecasters use daily surge-level maps produced by the system and their knowledge of local geography and tidal conditions to determine which areas of the Atlantic coast are most likely to be affected by surges. They recently added this information to the storm-surge prediction model to create an alert system that automatically warns them when water levels may exceed predetermined site-specific thresholds related to levels of flood damage. The new system was put to the test on February 6, 2001, when stage-one thresholds (the lowest of three) were forecast to be exceeded in some parts of PEI and eastern New Brunswick. Forecasters alerted the provincial Emergency Measures Office in Charlottetown, which monitored the situation and was able to provide sufficient advance notice that merchandise in several retail shops was protected from water damage.

The storm-surge prediction system is also currently being used in a case study on climate-change impacts and adaptation needs for PEI. One of the predicted impacts of climate change is an increase in average global temperatures—a phenomenon that would cause sea levels to rise due to thermal expansion and the melting of polar ice caps. Since the earth's crust is gradually subsiding in Atlantic Canada, coastal areas in the region will be lower in relation to the base sea level and, therefore, more susceptible to flooding.



Ice thrown onto the shoreline by the January 21, 2000, storm surge destroyed a building and nearly closed a road in Robichaud, New Brunswick, on the southern shore of the Gulf of St. Lawrence. Photo: Donald Forbes

Meteorologists also say that climate change could increase the frequency and severity of storms, which, combined with higher sea levels, could mean greater potential for damaging storm surges. In addition to using the prediction system to extrapolate future scenarios, researchers are looking at archival data for evidence of emerging trends.

The meteorologists are preparing a scientific paper on the storm-surge prediction system which they hope will be ready for publication in a scientific journal later this year. They will also present their report on the PEI climate-change case study at a public meeting to be held in Charlottetown in September 2001. S&E

NUTRIENTS IN THE ENVIRONMENT

Nutrients are essential to the growth and survival of all living organisms, and have a direct influence on the abundance and diversity of life on earth. Too much of a good thing, however, can cause environmental problems and affect quality of life. Increases in the amount of nitrogen and phosphorus in the environment, caused by human activities, are overstimulating the production of plants to the detriment of other species, and are linked to a variety of direct and indirect toxic effects.

Globally, the amount of available nitrogen in the environment has more than doubled since the 1940s, and available phosphorus levels have risen steadily as well. Each year, more than 304 000 tonnes of nitrogen and 12 000 tonnes of phosphorus enter Canada's ground and surface waters, and a further 1.4 million tonnes of nitrogen are released to the atmosphere, all as a result of human activity. Sharp increases in the size of our urban populations and their associated waste, the use of fertilizers, the burning of fossil fuels, and the clearing and deforestation of land all contribute to the problem. So far, the main impacts have been felt in our aquatic ecosystems, but some of our forests have begun to show early symptoms of nitrogen saturation.

Nutrients affect the environment by stimulating plant growth. When plant growth in an aquatic environment is overstimulated, it causes a significant change in the composition of the habitat and the diversity of the species found there. When certain species of plants choke out others, a ripple effect is felt by other species living in the ecosystem, including fish and invertebrates. A high density of plants also decreases the dissolved oxygen content of water through night-time respiration and oxygen consumption by bacteria that decompose dead plants. Few animals are able to survive in such oxygen-starved eutrophic lakes.

Nutrients also stimulate the growth of algae, including toxic algae, in both fresh and coastal waters. The consumption of water containing algal species that produce toxins or organisms that accumulate toxins (such as shellfish) can affect the health of terrestrial animals, including humans. Algae can also cause taste and odour problems in drinking water taken from surface water sources, particularly lakes and reservoirs.

Ammonia and nitrate, two forms of nitrogen, may also contaminate ground and surface waters. At high concentrations, both are toxic to aquatic and terrestrial animals. Nitrate has been identified as a possible contributing factor to a decline in amphibian populations, and ammonia discharges to fish kills. Surveys show that all provinces have some groundwater contaminated by nitrate; however, human fatalities due to high nitrate concentrations in drinking water are exceedingly rare.

Nutrients discharged directly onto land can upset the chemical balance of the soil and contaminate groundwater. Runoff carries excess nutrients from the land to the surface water, where they can cause acidification and eutrophication. Nutrients also enter the atmosphere, where they are carried long distances before falling back to earth through atmospheric deposition. Nitrogen in its various airborne forms contributes to the formation of smog and acid rain, and is a powerful greenhouse gas. The atmospheric deposition of nitrogen also contributes to the eutrophication of surface waters.

In response to concerns raised by the Parliamentary Standing Committee on Environment and Sustainable Development about the impacts and management of these key nutrients, and the fact that the only federal regulations governing them are for phosphorus levels in laundry detergent, the Government of Canada committed to undertake a full scientific assessment of nutrients in the Canadian environment. The results of the assessment, which has been under way since 1997, were recently released in a technical report produced by five federal departments and an Environment Canada State of the Environment Report.

Continued on page 7

Chemical fertilizers and manure applied to agricultural crop land to increase yields are the major non-point sources of nutrients released to surface and ground waters in Canada.

Continued from page 6

Scientists with Environment Canada, Natural Resources Canada, Fisheries and Oceans Canada, Agriculture and Agri-Food Canada, and Health Canada formed the assessment team that collected and interpreted the data—much of which had never been compiled and analyzed before. Their findings shed new light on how nutrients affect the environment, their impacts and potential for future damage, and the major sources of these compounds—all of which are important in determining steps for effective future action.

According to the reports, municipal sewage is the primary point-source of nutrient releases to surface waters in Canada—discharging about 80 000 tonnes of nitrogen and 5 600 tonnes of phosphorus annually. Although the level of sewage treatment across the country is generally improving as municipalities upgrade their wastewater treatment facilities, many communities discharging to coastal waters are still served by primary treatment or none at all. Septic systems, which serve just over a quarter of the population, also release nitrogen and phosphorus, which can travel into groundwater and, from there, to surface waters.

The major non-point sources of nutrients released to surface and ground waters are chemical fertilizers and manure applied to agricultural crop land to increase yields. Although nearly 90 per cent of these nutrients are taken up by crops, the excesses—estimated at approximately 293 000 tonnes of nitrogen and 56 000 tonnes of phosphorus annually—can contaminate runoff or seepage water.

Other sources contribute smaller quantities of nutrients, but are of serious concern in specific regions. These include aquaculture operations, which discharge up to 80 per cent of the nutrients fed to farmed fish as metabolic waste, feces and uneaten food. The farming of finfish in open-water cages is of most concern, as wastes from these operations are released entirely to the surrounding water. Industries with operating permits also discharge tonnes of nitrogen and phosphorus into

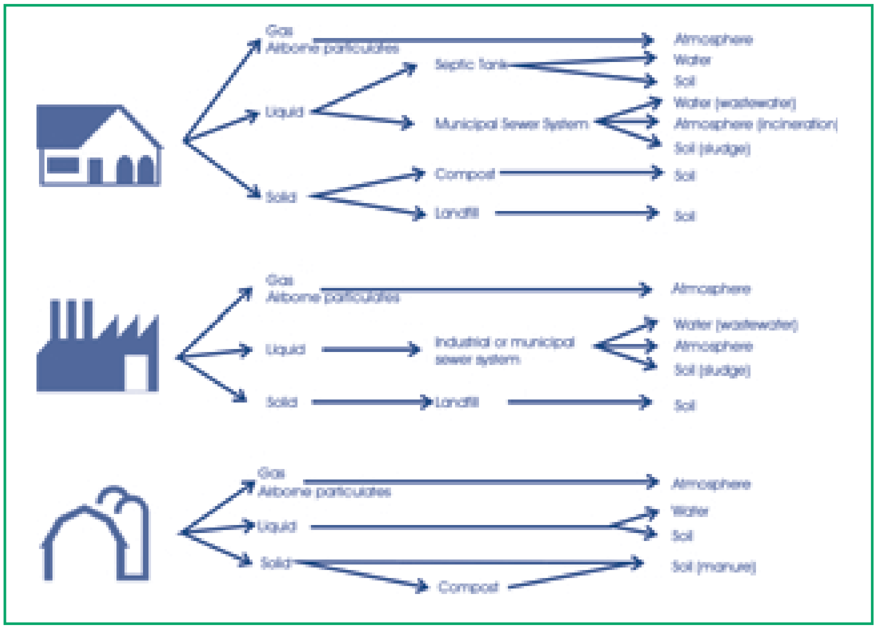


Illustration showing the different ways in which municipal, industrial and agricultural sources release nutrients into the environment, and where these nutrients wind up.

Canadian surface waters each year. Although their loads are estimated at less than one half and one seventh that of municipal sewage for phosphorus and nitrogen, respectively, not all industries are required to measure nutrients.

The largest source of nitrogen released into the air is agricultural activity, particularly the release of ammonia associated with the handling and application of manure and fertilizer. The combustion of fossil fuels—by the transportation sector in particular—is another significant contributor to air emissions of various forms of nitrogen. Industries also emit nitrogen to the air, particularly in the form of nitric oxide and nitrogen dioxide.

According to the reports, a wide range of measures have been and could be taken to help control nutrient inputs into the environment. For example, some municipal wastewater treatment plants employ advanced phosphorus removal before discharging their wastes. Most provinces now have guidelines for manure application to soil to balance the nutrient requirements of crops with the supply from the soil and fertilizers, and many farmers are adopting nutrient management strategies to reduce overfertilization. Technologies are now emerging for adding supplements to livestock diets to increase nutrient retention, which is currently only 20 to 40 per cent. Similarly, the development of more nutritionally balanced and digestible feed will reduce waste discharges at aquaculture operations.

The reports highlighted the need for the continued monitoring of nutrient emissions and ambient conditions, and for research into the effects of nutrient additions on ecosystem and human health. A multi-stakeholder workshop was held in March 2001 to discuss issues identified in the assessment and to come up with possible solutions. Environment Canada, Agriculture and Agri-Food Canada, and the Canadian Food Inspection Agency recently completed a review of the regulation of nutrients in Canada to help define the federal response to the assessment. A federal interdepartmental group will evaluate the results of the assessment, the regulatory review and the workshop, and recommend actions to help protect the health of Canadians and their environment from the impacts of this emerging issue. S&E

TOXIC CONTROL LIMITS: HOW LOW CAN YOU GO?

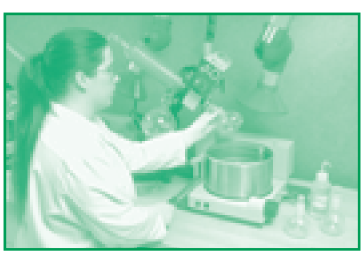
Canada's Toxic Substances Management Policy and the *Canadian Environmental Protection Act, 1999*, call for the virtual elimination of substances identified as "Track 1". These compounds, which result from human activity, are considered a risk to human and environmental health because they are toxic, persistent and bioaccumulative. The challenge for industries in trying to achieve this long-range goal is gauging how far they've come and how much further they have to go.

Environment Canada's Environmental Technology Centre (ETC) determines a benchmark for the virtual elimination of each Track-1 substance, known as the Level of Quantification (LoQ). Simply put, the LoQ is the lowest concentration of a compound that can be accurately measured using routine sampling and analytical methods. Since no quantity lower than this can be reliably measured, once the LoQ has been achieved, the compound is considered to have been virtually eliminated.

In working toward virtual elimination for specific sectors or sources, limits and timelines will be established based on economically achievable, best-available techniques. Examples of these include pulp and paper regulations for dioxins and furans, and Canada-wide standards for incineration and boilers burning salt-laden wood.

Determining how low you can go to measure a particular substance is not as easy as it sounds. First, it means identifying ways to detect the substance in the particular matrix in which it is found—be it air, soil or water—and separate it from all the other "background" components that could interfere with the reading. For each substance, a separate LoQ may be developed for each matrix, as required.

To accomplish this, the ETC scientists begin by carrying out a preliminary study of the matrices themselves. Various samples are taken back to the laboratory and their content carefully analyzed. Once their various components have been determined, minute concentrations of the substance are mixed into the matrix. The sample is then processed further and analyzed using a gas chromatograph/mass spectrometer, which separates the components of the sample so that the target substance can be more easily quantified.



An Environmental Technology Centre laboratory technician uses an evaporator to increase the concentration of a compound for analysis.

This process is repeated until the smallest consistently measurable quantity of the substance has been determined. This tends to be around 5 to 10 times higher than the smallest amount of the substance that can be detected in its undiluted form. The amounts measured by the analytical equipment are extremely low—the equivalent of measuring one second in 32 000 years. The LoQ is determined by multiplying the variability of replicate measurements (known as the standard deviation) at this concentration by 10—a formula recommended by the American Chemical Society based on intensive research and analysis. It means that repeated measurements of a sample containing a concentration near the LoQ value will be within plus or minus 30 per cent of that value 99 times out of 100.

While it is relatively simple to determine the LoQ of a substance in a known matrix under controlled laboratory conditions, it is less so for samples collected in the field. Field tests, however, are necessary to ensure that most variations that could occur in the collection of samples—particularly differences in interference caused by the background material contained in the matrix—have been considered. One of the greatest challenges of truth-testing LoQs in the field is that the cleanest possible sources must be sampled in order to confirm that the measured quantity is, in fact, as low as possible.

Since 1990, when the ETC produced its first LoQ for dioxins in pulp-mill effluent, Environment Canada has determined LoQs for polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, hexachlorobenzene, and polychlorinated biphenyls. Efforts are now focusing on determining LoQs for other compounds, such as those on the Priority Substances List, as they are assessed to be Track 1 substances. As more control limits are established, industries will be better able to chart their progress toward reducing emissions of toxic pollutants, and implement more effective plans for reaching the target of virtual elimination. 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.

Find out more about the subjects in this issue and previous ones by visiting our S&E Web site at [www.ec.gc.ca/science]. The on-line version of the *Bulletin* often contains additional information and graphic material and provides links to other relevant sites and documents. Many departmental publications mentioned in the *Bulletin* are posted on Environment Canada's Green Lane at [www.ec.gc.ca], or can be ordered from the Inquiry Centre at 1-800-668-6767.

For more information on a subject, you can search all of the on-line resources available from Canada's four natural resource departments — including *S&E Bulletin* — by using the CanExplore search engine at [www.canexplore.gc.ca].

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.