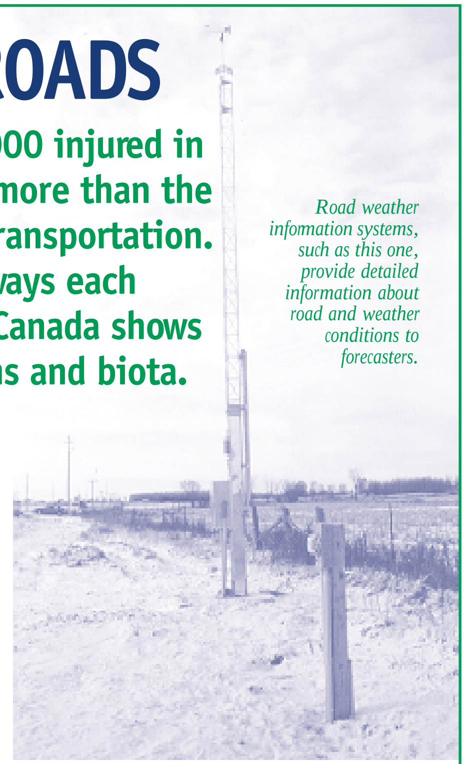
S&E SCIENCE AND THE ENVIRONMENT BULLETIN S&E

Issue No. 22 January/February 2001

SMARTER ROADS MEAN SAFER ROADS

Each year, approximately 300 Canadians are killed and 11 000 injured in road accidents in which snow and ice are a major cause — more than the annual total for all accidents involving all other modes of transportation. While the 4.7 million tonnes of road salt used on our highways each winter makes driving safer, a recent study by Environment Canada shows that it has numerous harmful impacts on freshwater systems and biota.



Road weather information systems, such as this one, provide detailed information about road and weather conditions to forecasters.

The need to improve public safety and reduce the environmental effects of chemical road treatment is prompting many provinces and municipalities to install hi-tech Road Weather Information Systems (RWIS) — automatic weather stations that are located adjacent to roadways and have sensors in the surface and substrate of the pavement. These systems record atmospheric conditions, such as air temperature, relative humidity and wind speed, as well as the temperature and wetness of the roads themselves.

Using its own heat-balance model, Environment Canada's Meteorological Service of Canada (MSC) combines RWIS data with atmospheric information to forecast the road-surface temperature and road conditions over the next 24 hours. Knowing in advance when black ice or other slippery conditions are on the horizon allows maintenance crews to apply salt *before* ice and snow bond with the pavement — the condition responsible for reducing the grip between rubber and road. This proactive approach to winter road maintenance is known as "anti-icing".

Since dry salt won't adhere to dry pavement, it has to be dampened before it is spread. In Sweden, the United Kingdom, and parts of the United States, where road-condition forecasts and anti-icing techniques have been in regular use for more than a decade, maintenance crews apply a thin film of brine solution. Studies have shown that pre-treating a road with brine requires up to four times less salt than applying dry salt to eat through accumulated snow and ice.

Anti-icing has enabled many road authorities in Europe and the US to reduce salt usage by 20-30 per cent while reducing accidents by 10-15 per cent. In fact, anti-icing has demonstrated sufficient savings in labour, equipment, supplies and fuel, to pay for the cost of RWIS and pavement forecasts twice over. Indirect benefits from reduced accidents, legal fees, and salt damage to roads, structures and the environment, and the more efficient use of existing roads are estimated to be 11 times the cost.

Canada currently has about 80 RWIS sites across the country, most of which are located in Ontario and British Columbia. However, major new RWIS installations are planned over the next five years that will boost that number significantly, and the federal government, provinces, territories and other partners are currently discussing the creation of a nationally integrated road weather system.

Since even several thousand sensors would fall short of providing coverage for the nearly one million kilometres of roadway across Canada, MSC hopes to use three-dimensional numerical weather prediction models to fill in the blanks. MSC's high-resolution supercomputer in Dorval, Quebec, would use data from the national RWIS network to produce road forecasts for all model grid-points coinciding with roadways — even those where no RWIS exists.

A nationally integrated RWIS network would result in a national highway system that is safer, more environmentally sustainable, and more efficient. Information obtained from the sites could be further enhanced by adding other equipment — such as visibility sensors, air-quality monitors, or traffic counters. Some regions are already planning to use RWIS data in the off-season for such purposes as determining the best time for planting and harvesting crops in nearby fields, and identifying conditions that could lead to forest fires. S&E

INSIDE

THE SCIENCE OF CLIMATE CHANGE

According to global climate models, the warming effects of climate change are greatest in the polar regions of the world — a phenomenon that could have devastating impacts on wildlife in the delicate Arctic ecosystem.

Our climate is changing more rapidly than it has at any other time in the past 1 000 years. Scientists predict that the global average temperature will rise by 1.5-6^{0} C by the end of the 21st century, and that Canada could see an increase greater than that. Such drastic warming will affect many other aspects of the weather, including wind patterns, precipitation, and severe weather events, creating serious consequences for humanity and the global environment.

The primary cause of climate change is the emission of greenhouse gases. Some of these, such as carbon dioxide and nitrous oxide, are produced through the burning of fossil fuels, wood and coal, while others, such as methane and halocarbons (e.g., chloro-fluorocarbons and hydrochlorofluoro-carbons) result from other human activities. These gases remain in the atmosphere for long periods of time, absorbing heat and radiating it back to the earth's surface — instead of allowing it to pass through into space.

As one of the parties to the United Nations Framework Convention on Climate Change, Canada is working to reduce its greenhouse-gas emissions to six per cent below 1990 levels by 2008-12. Last October, the Government of Canada released its $500-million *Action Plan 2000* — a strategy that focuses on key sectors and includes initiatives in transportation, energy, industry, buildings, forestry and agriculture, international projects, and science and technology. Combined with funding from Budget 2000, this brings the federal investment in tackling the threat of climate change to more than $1.1 billion. When it is fully implemented, *Action Plan 2000* will help move Canada one-third of the way toward meeting this goal of emission reduction. Subsequent plans, as well as actions by provinces, territories and industry, will bring it even closer.

Decision makers require scientific information in order to negotiate Canada's international position on climate change, and to determine appropriate ways to address the issue domestically. Much of this information comes from scientists in Environment Canada's Meteorological Service of Canada (MSC), who conduct research into the key processes of our climate system, monitor and assess the current state of the climate and the factors that influence it, and develop models to predict future conditions. They also study the impacts of climate change on natural and socioeconomic systems, and the ability of Canadian communities to adapt.

Such research shows that our climate system is a complex balancing act involving the sun, atmosphere, oceans and land. Solar radiation heats the earth and provides the energy that drives atmospheric circulation. The atmosphere screens out the sun's harmful rays and acts as a storehouse for various gases and particles. Both air circulation patterns and the make-up of the atmosphere have a major influence on climate and weather systems. Ocean currents and atmospheric circulation patterns help to moderate high-latitude climates, such as Canada's, by transfer-ring heat from the tropics toward the cooler poles. Other forms of water — from water vapour and precipitation to snow, sea-ice and the ice caps — also have an effect. Continents and their features absorb or reflect the sun's energy and affect air currents.

Humans have altered many different aspects of this climate system through economic and social development. To determine the impact these changes have had, scientists study data from historical instrumental and proxy records — such as tree rings, ice cores taken from ice caps, coral records, and sediment cores taken from lake and sea beds — to extend the climate record back as far as several thousands of years. These data are augmented by measurements of the current climate taken by volunteer and professional observers at hundreds of locations across the country. The resulting information is crucial for detecting climate change and making the link between changes and anthropogenic factors.

Canadian scientists are involved in several international efforts to help strengthen this link, among them the World Climate Research Programme. Canada's efforts under the program include ground-based measurements of surface radiation to help determine how much energy is entering and leaving the earth's atmosphere, studying ocean processes to improve global climate models, and the development and application of comprehensive regional and global climate models. Another major contribution is a study of water and energy cycles in the permafrost-saturated and largely snow-covered lands of the Mackenzie River Basin as part of the Global Energy and Water Experiment. This experiment will help improve understanding of cold regions and high-latitude hydrological and meteorological processes, and the role they play in the global climate system.

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MAPS HELP PROTECT SENSITIVE AREAS FROM SPILLS

Every second counts when there has been an oil spill at sea. The time it takes for emergency crews to respond can mean the difference between protecting vital resources and dealing with the repercussions of an environmental disaster. In situations where sensitive habitats or species at risk are involved, the damage may be irreversible.

Responders use laptop computers to access computerized sensitivity maps during an environmental emergency on the Atlantic coast.

To minimize the impact of spills on the Atlantic coast, Environment Canada scientists in Dartmouth, Nova Scotia, have developed a computerized mapping system that enables emergency responders to plan their strategies more quickly and effectively. This new program not only identifies the most important and vulnerable coastal resources at risk during an environmental emergency, but also recommends the best protection and clean-up techniques for the situation. It can also be used as a tool for pre-spill planning and training spill responders.

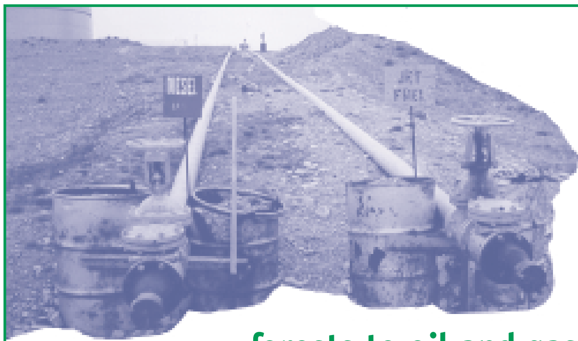
The Atlantic Region Coastal Mapping Project divides over 35 000 kilometres of shoreline into 12 000 segments with common physical features and geological structures. More than 140 different attributes describe each segment, including physical features such as the shoreline material and form (e.g., tidal mud flats, salt marshes, sand beaches); biological resources such as birds, fish, and mammals; and human-use resources such as aquaculture operations, parks, historic sites, and fishing harbours. Logistical and operational attributes — for example, staging areas, boat-launch sites, helicopter landing pads, and medical services — are also identified. Combining these data with information on the type and quantity of oil spilled, and current and predicted weather conditions, enables the user to determine the best course of action in an emergency.

The project encompasses all of the Atlantic region except Labrador, and includes detailed 1:50,000- and 1:250,000-scale digital topographic base maps and hydrographic charts, as well as aerial videos of each segment of shoreline. This system allows emergency personnel to generate reports, maps, and charts for a specific area affected by a spill. An on-line logging system enables the user to store and archive all incident reports, maps and photos generated during a spill incident for future use.

The computer mapping project has been under development for several years. Much of this time was spent tailoring the software, developing standards and protocols for data management, as well as collecting and inputting data. Unlike hard-copy sensitivity maps, which are derived mainly from published reports and government archives, the mapping software also includes an array of unpublished ecological data from local sources, such as community groups, First Nations, oil companies, and others. Also unlike hard-copy maps, computer maps are easily updated, and can be transmitted electronically with no loss in quality.

Although there are many potential users of sensitivity maps in Canada, the principal client for the Atlantic mapping project is the Regional Environmental Emergency Team — a multi-disciplinary group chaired by Environment Canada and made up of environmental and emergency services experts from the federal, provincial and municipal governments and industry. The team has already used the software for a number of emergency incidents, including to identify and protect sensitive resources from potential leaks during the raising of the oil barge *Irving Whale* in 1996, and to map the movement of debris and potential impacts of released fuel as a result of the Swiss Air crash off the coast of Nova Scotia in 1998.

The software has attracted significant interest both at home and abroad, and has been sent to Environment Canada offices in other regions — several of which are adding new components and adapting existing ones to their own purposes. The Department also plans to put the mapping system on its Internet site — the Green Lane — to increase its accessibility to users, and to enable the agencies involved to update their own data directly. In the meantime, discussions are ongoing with community and First Nations groups to assist in compiling the required data for Labrador. S&E



MANAGING CUMULATIVE EFFECTS IN THE NORTH

Canada's North is blessed with an abundance of valuable natural resources — from diamonds to forests to oil and gas. The rapid development of these resources is putting significant pressures on the environment, highlighting the need to take a broader regional approach to managing the potential impacts of all development.

Even seemingly minor stresses caused by human activity can result in unexpected changes in an ecosystem. To prevent or mitigate such changes, scientists and those with traditional knowledge gather baseline information on the current state of the environment, and try to predict the short- and long-term effects of a proposed project. It is also important to consider how the impact of stresses from other human activities would combine with these effects.

Cumulative effects assessments are a common requirement for resource planning and management in the North. However, the current process has several shortcomings. Since they are specific to each individual project, the assessments are unable to consider adequately the combined effects of all of the developments in an area of interest. In addition, a lack of standard protocols for the collection and storage of baseline and monitoring data, combined with multiple project reviews, can lead to capacity limitations and consultation fatigue — particularly in small northern communities.

Determining how the addition of a project to other projects in an area will affect the region over time is especially important when the footprint of that project covers a vast area. A Cumulative Effects Management Framework can help to establish and maintain baseline information for an entire region, and identify important ecosystems and natural resources. This information can then be used to assess and manage the potential impacts of all present and future developments in the area.

Such a framework has proven a useful tool for dealing effectively and efficiently with multiple proposals for hydrocarbon developments in the Athabasca Oil Sands of northern Alberta. A multi-stakeholder body developed a Regional Sustainable Development Strategy, which provided a framework and process for addressing the area's growing number of environmental issues.

Environment Canada and Indian and Northern Affairs Canada, in partnership with other northern organizations, are working to develop a Cumulative Effects Assessment and Management Framework for the Northwest Territories. Environment Canada has also developed a generic regional management framework for the North that promotes the principle of best practices.

According to both frameworks, several key components are required to effectively manage cumulative environmental effects. In addition to thorough cumulative effects assessments of all proposed projects, these include: a regional steering body made up of all affected and interested groups; a regional monitoring program to provide feedback on ecosystem health and change; consultative land-use and watershed planning; an accessible central database; and a research body to address questions about environmental thresholds and impact predictions.

In parts of the North, some of these components are already in place as requirements of comprehensive land-claim agreements. As a result, the completion of a framework in those areas would only require identifying and filling in any gaps.

As progress is made in the development of regional cumulative effects management frameworks in northern Canada, the effort required to establish each framework will bring benefits. The end result will not only help to make the cumulative effects assessment process more efficient, but also ensure that better, more forward-looking management plans are in place to protect the vulnerable northern environment. 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.

ISSN 1480-3801

ARTIFICIAL STREAMS PINPOINT EFFECTS OF AQUATIC STRESSES

Aquatic plants and animals are often exposed to more than one environmental stressor at a time — for example, municipal sewage combined with the nutrients and contaminants from pulp-mill effluent. Assessing the cumulative effects of these substances on aquatic organisms has been a difficult task until recently, when scientists at Environment Canada's National Water Research Institute (NWRI) developed a system for evaluating individual and combined impacts.

Cumulative effects assessments are required for all proposed developments under the *Canadian Environmental Assessment Act* as a means of predicting adverse impacts and designing ways to prevent or mitigate them. The problem is that it is not always easy to determine which substance is causing which effect, or to what extent the presence of one substance lessens or increases the effect of another. Many of the standard techniques used for bioassessment cannot establish a clear cause-and-effect relationship. In the natural environment, for example, researchers cannot always be certain about the concentration or duration of exposure, nor can they easily replicate experiments.

Over the past six years, an NWRI research team has developed a mesocosm, or artificial stream system, that can "tease out" the effects of multiple stressors, such as nutrient-contaminant or metal-contaminant interactions, and multiple metal contaminants. This allows them to examine the effects of individual stressors and also to evaluate their combined effects.

The mesocosm system bridges the gap between laboratory studies, where variables are strictly controlled, and the natural world, where researchers have very little control over factors affecting their experiments. It consists of a series of circular streams — the originals had a volume of approximately half a cubic metre each — that are transported to the riverside on a flatbed truck. Under ambient light and temperature conditions, river water is pumped through the streams to simulate its current. Substrates, or stream beds, are created using rocks and other river materials, and a "biofilm" — made of sediment and tiny organisms that have settled out of the water — is given time to develop before benthic, or bottom-dwelling, invertebrates and small fish are introduced.

Field-based artificial stream system used for assessing the ecological effects of effluents on riverine ecosystems.

Researchers have used the system to study the effects of pulp-mill and metal-mining effluent in several large rivers across Canada: the Athabasca River in northern Alberta, the Thompson and Fraser rivers in British Columbia and, most recently, the Saint John and Little rivers in New Brunswick. They focussed their attention on impacts on benthic communities, looking at community structure and at the growth and reproductive health of various community members.

In the Athabasca experiment, researchers were able to separate the effects of contaminants and nutrients in bleached-kraft pulp-mill effluent on benthic algae and invertebrates using three treatments: the first containing no effluent; the second containing the one-per-cent effluent concentration typically found in the river; and the third containing a nitrogen-phosphorus solution with nutrient levels similar to those of the effluent treatment.

They found that, relative to the control treatment, algal growth and insect numbers increased with exposure to both the effluent and nitrogen-phosphorus treatments, and there was a shift in algal community structure. Algal and insect biomass did not differ significantly between the two treatments, suggesting that at concentrations found in the Athabasca River, the response to nutrient enrichment overwhelms any negative effects caused by the contaminants.

Since the Athabasca study, NWRI has refined its system and now uses much smaller mesocosms that can be transported more easily and cost-effectively to the research site. With support from the federal Toxic Substances Research Initiative, researchers are currently evaluating the system's effectiveness in assessing impacts not only on algae and benthic invertebrates, but also on fish and the aquatic ecosystem as a whole — research that contributes directly to the efforts of government and industry to reduce risks to the Canadian environment. S&E

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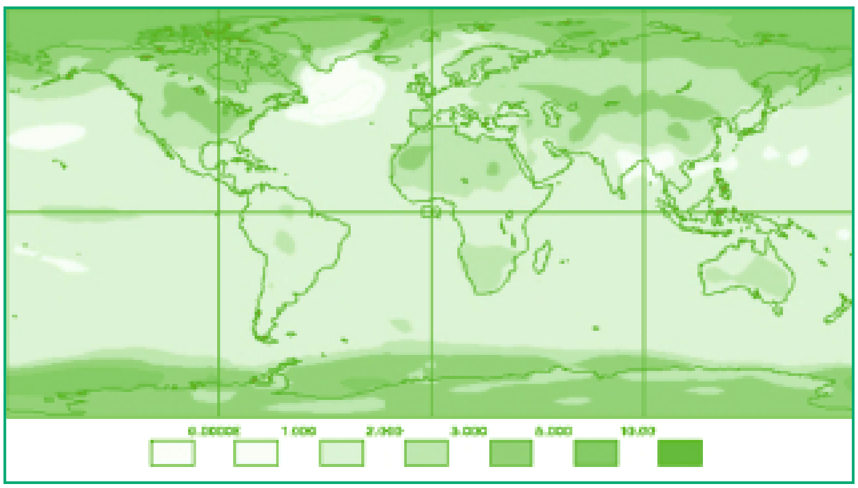
Since the primary influence on climate change has been changes to the chemical composition of the atmosphere, the study of greenhouse gases and their natural cycles has been an area of increasing focus for scientists. Of particular interest is determining how much of the carbon contained in emitted greenhouse gases ends up in natural "sinks" in our oceans, forests, soil and wetlands. In addition to taking regular measurements of greenhouse-gas concentrations in the Arctic, on the east and west coasts, and in the Pacific Ocean, MSC researchers also participate in major field programs, including a collaborative project examining greenhouse-gas fluctuations and carbon sequestration in the boreal forest.

All of this information contributes to the creation of global climate models — powerful computer simulators that use complex mathematical approximations of the physical and, to some extent, biological and chemical processes that underlie the global climate system. Researchers at MSC's Canadian Centre for Climate Modelling and Analysis (CCCma) in Victoria, British Columbia, develop and use one of the world's most sophisticated coupled climate models, incorporating interacting atmospheric, land, ocean and sea-ice components, to study the mechanisms of climate variability and change and to make projections of future climate.



Projected change in surface temperature around the world between 1980 and 2050. This projection was generated by the Meteorological Service of Canada's second-generation coupled global climate model when forced with a widely used scenario of future emissions. The darker the shading the greater the projected change.

The Centre recently modelled the effects of an increase in greenhouse gas and aerosol concentrations from 1850 to 2100 using MSC's supercomputer in Dorval, Quebec. The result of this extensive computing effort shows a strong correlation with past trends determined from historical and proxy records. It predicts that global warming and other effects of climate change over the next century will be greatest over land and at high altitudes, and that there will be an increase in global precipitation and a decrease in sea-ice and snow.

To bring together the many kinds of expertise required to develop and enhance global coupled climate models such as this, the Centre has collaborated with nine research groups in 18 Canadian universities and government labs in the Canadian Climate Research Network over the past six years. An important aspect of the Network's efforts has been to embed regional climate models in the CCCma's global coupled model, so that more precise projections of climate change can be made on regional scales. In addition, Network research groups have worked to improve the representation of oceanic and sea-ice processes, clouds and radiation, stratospheric chemistry, and the land surface.

Projections of future climate are used by scientists for climate impact studies, and to formulate strategies for responding to climate change. Selected data from Canadian simulations have been provided to the Intergovernmental Panel on Climate Change for use in its global climate change assessment reports. Environment Canada scientists were lead authors, contributors and reviewers of the first two reports, and are participating in the production of the third report, which will be completed by the middle of this year. The Canadian model was also used in a national assessment of the potential impacts of climate variability and change in the United States. Results from the CCCma model are available on-line at [http://www.cccma.bc.ec.gc.ca].

The U.S. assessment incorporated many features of the Canada Country Study, in which Environment Canada worked with more than 55 experts from across Canada to survey and synthesize research on the social, biological and economic impacts of climate change. The study revealed a variety of far-reaching effects, including: earlier harvests and a greater risk of pests and disease for grain crops; the movement of forests and forest species further north and to higher altitudes; more illnesses and deaths from the increased frequency and severity of heatwaves and smog episodes; the possible migration of sub-tropical diseases northward; and threats to freshwater and wetland species and habitat due to decreases in lake and groundwater levels.

A similar effort is currently being carried out on a more regional scale, as MSC scientists strive to incorporate climate change impacts into the Georgia Basin Quest computer simulation program. The program will enable people to see the impacts their activities — including the production of fossil fuels — will have on water resources, agriculture, forestry, fisheries and air quality in the future. Other ongoing projects include the examination of the potential impacts of climate change in national parks, appraisals of the costs and benefits of climate-change impacts, and the development of adaptation options for various sectors.

Continued investment in research, both within government and the university sector, is key to improving our knowledge of how the different components of the climate system interact, creating more advanced models, and sharpening our predictive capabilities. It is through this research that we will be better able to minimize human impacts on climate, and better equipped to adapt to these changes. S&E

PROJECT GIVES ELECTRIC VEHICLES A BOOST

Electric vehicles (EVs) are slowly merging into the commercial market as a result of more stringent clean-air measures in major cities around the world. Still rare at best in Canada, a recent project is proving that — even in the battery-draining depths of winter — EVs are a cost-effective alternative for fleets operating in an urban environment.

The Solectria Force, pictured here on Parliament Hill in Ottawa, is one of several electric vehicles tested in the Montréal 2000 Project.

The Montréal 2000 Electric Vehicle Project, which began in January 1999, is the first effort of its kind in Canada to test the performance of commercially available EVs by incorporating them into intercity commercial and institutional fleets — an application ideally suited to vehicles that can currently travel a maximum of 80-130 kilometres before they require recharging.

The more extensive use of EVs for such purposes would also drastically reduce emissions of greenhouse gases, over 40 per cent of which are produced by road traffic in Quebec. Since electric vehicles produce no emissions, switching from an internal combustion engine to a battery-operated one would cut CO_2 emissions by over 3.8 tonnes per vehicle per year. EVs are also 85-per-cent energy-efficient, while gas-powered vehicles are only 30-per-cent. That makes them up to four times cheaper to operate — a factor that helps offset the fact that they cost two-and-a-half times as much to buy.

Ten partners from the federal, provincial and municipal governments and the private sector — including Environment Canada, National Defence, Transport Canada, Canada Post Corporation, the Government of Quebec, Bell Canada, Hydro-Québec, Les Services électriques Blanchette, the City of Montréal and the Centre d'expérimentation des véhicules électriques du Québec (City of Saint-Jérôme) — are testing 23 EVs under the program. These range from the compact Ford Ranger pick-up truck to the Solectria Force sedan and two-seater Ford Think City, as well as two modified delivery trucks.

The $3-million project is taking place in the Greater Montréal area, where two EV car dealers are present and a network of 25 public and private recharging stations has been created. Quebec is considered a prime market for EVs because it is Canada's second-largest light-vehicle market. Of the more than 3.5 million cars and light trucks on the road in the province, over 11 per cent are used in institutional and commercial fleets. Hydro-electricity is Quebec's major energy resource, so it also boasts the highest difference in North America between the costs of electricity and petroleum (1:5), making EVs even more attractive to fleet managers considering a conversion.

The theory is that if EVs can perform in hot, humid summers and bone-chilling winters in Montréal, they should be able to perform in just about any climate. To determine how well they fare, two evaluations are being carried out: one uses data from onboard sensors and user logs to assess technical performance, the other interviews and surveys with drivers, fleet managers and maintenance people to gauge satisfaction, perception and reaction to EVs.

Environment Canada reported on findings for the first year of the project at the 17th Electric Vehicle Symposium in Montréal in October. Data obtained show that EV usage increases with availability and that, despite some interruptions caused by parts recalls in the United States, the vehicles meet performance requirements.

Seasonal data confirmed that temperature and climatic conditions play an important role in performance — with accessories, such as the heating system, consuming 25 per cent of available energy at temperatures below -10 ^{0}C. Although this shortens the distance EVs can travel in cold conditions, new lithium-metal-polymer batteries that have twice the range of current lead-acid and nickel-metal-hydride batteries will become commercially available in 2004. The lithium batteries also last more than 10 years.

Participants are hopeful that the results of the project, which is slated to wrap up at the end of March, will help to allay concerns about the new technology. All have expressed interest in taking part in subsequent phases of the project, and Renault has agreed to have its Kangoo Van included in future testing. S&E

ECOLOGICAL GRAZING REJUVENATES NATIVE PRAIRIE

Conservationists and cattle producers are working together to restore native prairie in the Last Mountain Lake National Wildlife Area in south-central Saskatchewan. Using an ecological grazing system, cattle from nearby pastures are helping to control the spread of exotic species and reintroduce a diversity into the ecosystem that existed years ago when bison roamed the prairies.

Environment Canada's Canadian Wildlife Service and Agriculture and Agri-Food Canada's Prairie Farm Rehabilitation Administration (PFRA) launched the project six years ago in response to a steady decline in habitat quality and biodiversity in the area. Left idle for decades, the land was succumbing to a takeover by alien plant species, which were choking out native plants and diminishing the variety of habitat available to birds, invertebrates, and other animals.

Scientists have recognized for several decades that both fire and grazing need to be reintroduced to the prairie landscape, since both played a significant role in its formation. Prescribed burning is used at Last Mountain Lake, but is costly and complex. Burning also requires specific weather and environmental conditions, so it is not always possible to carry out burns as planned or required.

Enter cattle. The ecological grazing project uses a system of rotational cattle grazing that biologists believe closely mimics historic bison grazing patterns, which were brief but intensive. When roaming herds happened upon the shores of a lake or river, they had a significant impact on the environment and then left, allowing the land to recover. This created the kind of open habitat many bird species require during molting and migration.

To replicate this bison grazing pattern, scientists modified the intensive rest-rotation grazing commonly used by farmers to allow pastures to recover from the pressures of livestock. Through the use of gates, electric fences, and other barriers to control their movement, cattle are directed to a specific site, allowed to graze for several weeks, and then directed to another site — making it possible to cover large tracts of land over the course of the season.

At Last Mountain Lake, cattle are left to graze long enough to reduce the existing growth to a height of two to five centimetres, and then moved. They are also only allowed access to a certain percentage of shoreline area in a given year. This treatment is applied three years in a row, and then the land is allowed to rest for three to six years.

This year, each grazing unit was divided in half, with half receiving the three-year grazing treatment and the other half being rested to allow litter and growth to build up. Creating a patchwork of smaller mosaics in this way will create more structural complexity and variability in the vegetation in a given area. This will provide more habitats for a wider variety of bird and invertebrate species, as well as assist in the pollination, flowering, and seed production of native plant species.

Environment Canada gathered data on bird and other species populations in each segment of the wildlife area before the cattle were introduced, and is closely monitoring the changes that have since taken place. So far, in areas that have been subjected to ecological grazing, the growth and seed production of exotic species, which are not accustomed to being grazed, have been eliminated or greatly reduced. This has helped level the playing field for native grasses, which originally took root when grazing and grass fires were a natural part of their lifecycle. These native species are gaining ground and may eventually take over in areas where the two now compete.

The PFRA also benefits greatly from managing the cattle and assisting with range monitoring. Access to the wildlife area's rangeland is helping to rest and rejuvenate over-stressed community pastures, as well as providing cattle with an abundant source of high-quality forage. Since the project started, calves grazed on the wildlife area have gained an average of 50 pounds more than those grazed on the community pasture.

In ensuring the long-term sustainability of native prairie habitat and biodiversity, and improving productivity for private cattle producers, the ecological grazing system project is creating a template for others to follow in managing our valuable natural resources. S&E

Cattle grazing at Last Mountain Lake National Wildlife Area in south-central Saskatchewan.