S&E SCIENCE AND THE ENVIRONMENT BULLETIN S&E
Issue No. 32 September/October 2002

ABORIGINAL TRADITIONAL KNOWLEDGE AND ENVIRONMENTAL MANAGEMENT

Over centuries of living in harmony with their surroundings, Aboriginal peoples in Canada have gained a deep understanding of the complex way in which the components of our environment are interconnected. In recent years, a growing awareness among non-natives of the value of this traditional knowledge (TK) has increased efforts to link it with science, particularly in the area of environmental management.

A number of resource-management boards, commissions, projects and legal agreements—including the *Convention on Biological Diversity* and the proposed *Species at Risk Act*—recognize this value, and encourage the participation of Aboriginal people and the use of traditional knowledge in decision making. Environment Canada is engaged in a variety of efforts to supplement its science with traditional knowledge, and build the capacity of Aboriginal communities to manage their resources.

Aboriginal traditional knowledge has been and continues to be accumulated through time spent living on the land. It encompasses all aspects of the environment—biophysical, economic, social, cultural and spiritual—and sees humans as an intimate part of it, rather than as external observers or controllers. TK is part of the collective memory of a community, and is passed on orally through songs and stories, as well as through actions and observation.

This holistic view of the environment is based on underlying values that support sustainability. They include taking only what is needed and leaving the rest undisturbed, and providing for the well-being of the community without jeopardizing the integrity of the environment. The belief that all living creatures deserve respect has enabled Aboriginal peoples to hunt, trap and fish, while at the same time conserving wildlife populations for future generations.

In addition to an understanding of environmental systems as a whole and knowledge of appropriate techniques for harvesting, TK includes qualitative information on animals, plants and other natural phenomena. While significantly more knowledge is available on species that are harvested (such as caribou, seals, whales and fish), Aboriginal hunters, trappers, fishers and gatherers are also aware of the presence and biology of other species in the local environment. Elders, who are the main knowledge-keepers, are astute at noticing subtle patterns and changes within ecosystems.

Elders, hunters, trappers and other members of Aboriginal communities have accumulated valuable knowledge about their environment as a result of centuries of living on the land.

While TK was often dismissed in the past due to its anecdotal nature, it is an important piece of the puzzle. It has helped scientists recognize and evaluate species and spaces at risk by providing information on broad trends in species distribution, abundance and seasonal behaviour patterns, and saved time and money by guiding field work.

To help break down some of the barriers between TK and science, Environment Canada researchers and officials working under the Northern Contaminants Program have taken part in several Elder/scientist retreats. The two groups meet in northern camps to share their knowledge and thoughts about changes in the environment. Thanks to such efforts, scientists are now

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addressing more relevant research questions, and Aboriginal peoples are becoming more comfortable with the concept of sharing their TK.

Environment Canada scientists collect TK in both formal and informal ways. One formal method is by conducting interviews with knowledge-keepers—often with the assistance of staff or community members who speak both the interviewee's native language and either English or French. To avoid misinterpretation, questions are straightforward, and are often assisted by the use of maps or photographs.

Such interviews have yielded valuable information on historic and present patterns in land use, wildlife and other aspects of local ecosystems. For example, an important component of the Northern River Basins Study was to determine how TK could complement physical-science studies of northern Alberta's aquatic ecosystem. Hundreds of maps were created from archival records and interviews with long-term residents. In another instance, EC scientists partnered with a local hunters and trappers association to interview Elders in Pangnirtung, Nunavut, about seals, polar bears and ice patterns. The baseline data they provided is being used to monitor the impacts of climate change and contaminants on the region.

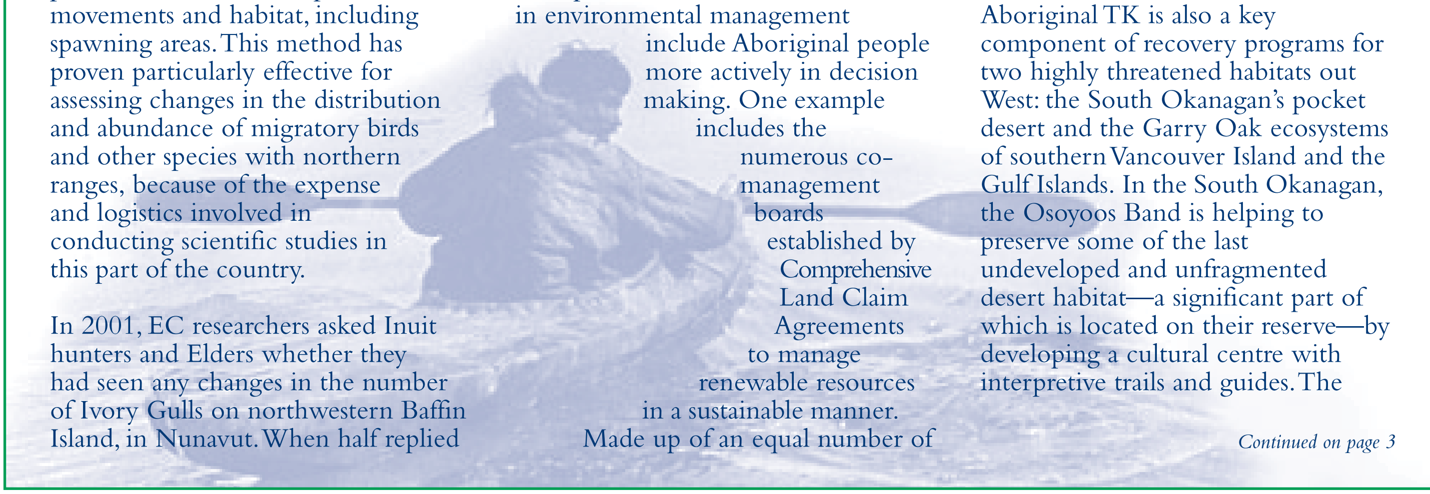
Interviews are also useful for collecting TK on the status of species. For example, Gwich'in Elders and fishers helped biologists identify Dolly Varden char as "at risk," and provided details on the species' movements and habitat, including spawning areas. This method has proven particularly effective for assessing changes in the distribution and abundance of migratory birds and other species with northern ranges, because of the expense and logistics involved in conducting scientific studies in this part of the country.

In 2001, EC researchers asked Inuit hunters and Elders whether they had seen any changes in the number of Ivory Gulls on northwestern Baffin Island, in Nunavut. When half replied that they had observed fewer gulls in recent years, a survey was carried out, revealing that breeding colonies in the area had declined by some 90 per cent. Interviews about birds and mammals at risk in the region also provided the first evidence in 70 years that Harlequin Ducks were still breeding on the island.

Also in Nunavut, perceived declines in Common Eider populations reported by Inuit hunters near Sanikiluaq led to surveys that confirmed a 75 per cent decline over the previous survey period. The hunters provide detailed observations for the annual life cycle of the Hudson Bay subspecies, and have helped identify important relationships between eider distribution and ice movement, winter mortality and eider age, nesting success and fox occurrence, and physical condition and seasonal changes in diet.

EC scientists and researchers also involve Aboriginal people as guides and assistants in sampling and surveying efforts, with both parties learning from the informal discussions that take place. For example, while working closely with Aboriginal guides in the Northwest Territories to collect fish and water samples, National Water Research Institute scientists have learned much about observed changes in fish health, harvesting, and important features of the fish's environment.

Since TK loses much of its relevance when removed from the context of its source, many recent efforts to incorporate this kind of information in environmental management include Aboriginal people more actively in decision making. One example includes the numerous co-management boards established by Comprehensive Land Claim Agreements to manage renewable resources in a sustainable manner. Made up of an equal number of Aboriginal and government representatives (including Environment Canada), these boards share scientific and traditional knowledge on everything from wildlife and water to land-use planning. All of their decisions are made by consensus.



BEST PRACTICES FOR TRADITIONAL KNOWLEDGE

- Respect the ownership, source and origins of the knowledge and the needs and sensitivities of its holders, and obtain their approval and involvement.
- Take the time needed to establish a strong, trusting relationship based on honesty, openness and sharing.
- Work on projects of common interest and benefit.
- Continuously foster communication between partners.
- Provide value-added knowledge back to the community in the form of useful products (such as reports) and services, and share equitably with the holder any benefits arising from the use of TK.

In British Columbia, Environment Canada has been working for several years to build partnerships with Aboriginal peoples to achieve important conservation objectives. A key element of this strategy has been the creation of conservation interns who work with the department to inventory populations and habitats on their territories. Such capacity building is aimed at better equipping Aboriginal communities to handle future resource-management responsibilities.

Aboriginal TK is also a key component of recovery programs for two highly threatened habitats out West: the South Okanagan's pocket desert and the Garry Oak ecosystems of southern Vancouver Island and the Gulf Islands. In the South Okanagan, the Osoyoos Band is helping to preserve some of the last undeveloped and unfragmented desert habitat—a significant part of which is located on their reserve—by developing a cultural centre with interpretive trails and guides. The

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strategy for Canada's endangered Garry Oak ecosystems incorporates aspects of historic Aboriginal management regimes, such as the use of prescribed fire, active cultivation techniques, and the harvesting of traditional foods on some of the few remaining tracts of these grassy parklands.

On the other side of the country, the Ashkui Traditional Ecological Knowledge Initiative is using the knowledge of the Innu people to examine the landscape and ecology of northern Labrador. With large-scale development pressures in the region increasing, and a lack of scientific information available for environmental assessments, the Innu and Inuit are an important source of ecological knowledge. Environment Canada scientists worked closely with Aboriginal Elders to learn more about elements of the land that are critical to the Innu culture and way of life. Together, they decided to focus their collaboration on *ashkui*—the areas of rivers and lakes that are first to become free of ice each spring.

The first couple of years of the Ashkui Initiative were spent building relationships between Elders and scientists, conducting interviews, shaping the project, and finding study areas of common interest. Meetings were held in camps, with scientists spending several days at a time on the land. Traditional knowledge was compiled into a database, and a series of scientific questions were formulated as the basis for research at 13 ashkui sites. Added value is provided back to the community through such products as newsletters, posters, CD-ROMs, technical reports on water quality and potability, and spring ice-risk maps.

The Ashkui Initiative has spawned several offspring. For one, the project is expanding to study another site of great importance to the Innu—the intersections where caribou paths merge at certain times of year. Scientists are also creating an on-line mapping atlas for Labrador that will enable developers and others to see the value of the landscape to Aboriginal communities. Environment Canada is helping to build capacity within the Innu nation through the university-accredited Environmental Guardians Program, which trains and involves Innu students in planning, report-writing, wildlife monitoring, water chemistry, and other hands-on environmental work. The guardians, who will soon have a permanent office, serve as an important conduit for the flow of information to and from the community.

Ashkui, like this one on Shipiskan Lake in Labrador, have long been important sites for Innu camps during the spring. These early open-water areas are the subject of a major cooperative study involving Aboriginal people in the area and Environment Canada scientists.

In the North, Aboriginal people play an active role on the steering committees of such major projects as the Northern Ecosystem Initiative. A variety of efforts under this initiative link traditional knowledge and science. Among them is the Arctic Borderlands Ecological Knowledge Cooperative—a community-based monitoring program that focuses on large-scale trends in climate change, contaminants and regional development in the Porcupine caribou range. Aboriginal assistants interview hunters, trappers and others in their own communities about observations made over the past year of caribou, fish, berries and other environmental indicators. In addition to being part of the department's ecological monitoring network, this information feeds into a number of other programs.

More science projects in the North are also being driven by traditional knowledge. For instance, the Vuntut Gwich'in people, who have traditionally hunted and trapped in the Old Crow Flats of the northern Yukon, told biologists that water levels in the more than 2000 shallow lakes and ponds in the flats have dropped over the past decade. A research team used satellite images and aerial photos to examine the situation, and confirmed that some lakes are draining catastrophically and a large number are drying up—another possible indicator of climate change.

In the South, where traditional knowledge has long been part of consultations with Aboriginal peoples, Environment Canada is taking steps to develop more formalized processes. In Ontario, the last two State of the Lakes Ecosystem Conferences featured special sessions on traditional knowledge, and invited Aboriginal people to provide direction on how science and TK can work together. The result is a co-existence model that recognizes the value of both types of knowledge, and uses relevant information from each to address issues of common interest, such as water quality and invasive species.

While documented TK is already being incorporated into species reports, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is currently creating an Aboriginal traditional knowledge sub-committee to determine, among other things, how to involve Aboriginal communities more directly. Environment Canada is also in the process of developing a guide on the collection, documentation and use of TK that will establish protocols and high standards of ethics for partnerships and initiatives involving Aboriginal people.

In the meantime, the ongoing use of informal methods to incorporate TK in regional initiatives across the country will continue to reveal best practices for linking this age-old wisdom with scientific expertise. Each piece of the puzzle improves our understanding of the many and complex influences affecting our environment, and the steps we must take to ensure its sustainability for future generations. S&E

SAVING THE LOGGERHEAD SHRIKE

In August 2002, 14 juvenile Eastern Loggerhead Shrikes left the confines of the cages where they were conceived to face an uncertain future in the wild. The experimental releases near Ottawa were part of an ongoing effort to develop techniques for increasing the breeding success of these endangered birds in captivity.

Eastern Loggerhead Shrikes. Photo: Amy Chabot.

A recovery team has been struggling for the past decade to determine why this predatory songbird is in decline. Although no clear answer has emerged, the loss and fragmentation of grasslands—where the eastern subspecies hunts for mice, grasshoppers and other small prey—is likely a key factor.

In the first half of the 20th century, the clearing of land for agriculture and the use of grasslands for pasturing livestock contributed to the expansion of the bird's range. In recent years, however, conversion of pastures and hayfields to cropland has reduced shrike habitat.

In Canada, where it was once abundant from Manitoba to New Brunswick, the Eastern Loggerhead now numbers about 40 breeding pairs in the wild—at one location in southeastern Manitoba and two in Ontario. In 1997, when there were only 18 pairs in Ontario, Environment Canada and its recovery team partners began establishing a captive population to ensure that the unique genetic material of the Canadian birds would be preserved.

A total of 43 nestlings were taken to aviaries at the Toronto Zoo and McGill University in 1997 and 1998, and the first captive breeding occurred. In 2001, the Wildlife Preservation Trust Canada—an organization with international expertise in captive breeding and release of birds—joined the recovery team. With the cooperation of local landowners, the trust bred six shrikes—themselves captive bred—in field propagation/release cages in the Smiths Falls area, southwest of Ottawa. Three pairs raised 10 young shrikes, which were released into the wild.

In 2002, the experiment involved more birds and improved cage designs. The cages measured about 4m x 4m x 2.5m, with each pair sharing two units linked by a mesh corridor that was temporarily blocked off. The male and female were only allowed to mix after the male approached the female with food and nesting material. All six pairs built nests, with five pairs producing 21 young, and one of the five pairs successfully nesting twice. As before, the baby birds learned to hunt live insects and honed their flying skills while they were still in their cages.

The birds' behaviour was monitored by remote video systems mounted in the cages and by telescope from nearby blinds. Elevated feeding platforms were located outside the release door, so that juveniles could exit without stress. Although some returned for food for up to a week, they were observed hunting, avoiding predators and flying with confidence immediately following release. Birds that were hatched at the Smiths Falls facility in 2002 but not released will be returned to the site next summer to breed and be released with their young.

Before the start of the 2003 nesting season, a satellite facility will also be established at Prince Edward Point National Wildlife Area on Lake Ontario, near Picton. Eventually all captive loggerheads will be located at such facilities, each in an area of planned restoration within their historic range. This will enable the birds—which are believed to migrate at night—to imprint on the night sky in their natal area.

The status of the Eastern Loggerhead in the wild remains precarious. Not only is the subspecies faced with such new threats as West Nile Virus, but there also remains a lack of knowledge about, and therefore protection on, its wintering territories in the United States. As such, plans are currently underway to engage the help of wildlife biologists in states where the birds may be found.

Meanwhile, Canadian recovery efforts are ongoing to protect and restore habitat, conduct research on the genetic makeup of sub-populations, carry out stable isotope analyses, band birds, monitor populations and habitats, and identify critical habitat for this endangered species. S&E

THE MYSTERY OF THE DRY WETLANDS

Small wetlands or "sloughs" are a distinctive feature of the prairie landscape, and provide important habitat for wildlife—including serving as a breeding ground for nearly half of all North American ducks. Recent studies of sloughs at a National Wildlife Area in Saskatchewan, however, have shown that some efforts to better manage the land around these productive areas are actually leading to their disappearance.

The Canadian prairies are dotted with literally millions of sloughs, each of which typically has a central pond surrounded by a ring of willow trees and other vegetation. In spring, when the ground is still frozen and cannot absorb much water, the water from melting snow trickles down slopes and into the sloughs, where it recharges groundwater, sustains the surrounding vegetation, and creates living space for ducks, frogs and other aquatic creatures.

Since most sloughs dry out and disappear without this yearly replenishment, changes in farming practices or climate that affect spring runoff can have major consequences for the wetlands and waterfowl. To get a clearer picture of what has been happening to these sloughs in recent years, scientists with Environment Canada's National Water Research Institute and Canadian Wildlife Service, with the help of university partners, are studying the hydrological processes and aquatic ecology of prairie wetlands at the St. Denis National Wildlife Area in southern Saskatchewan.

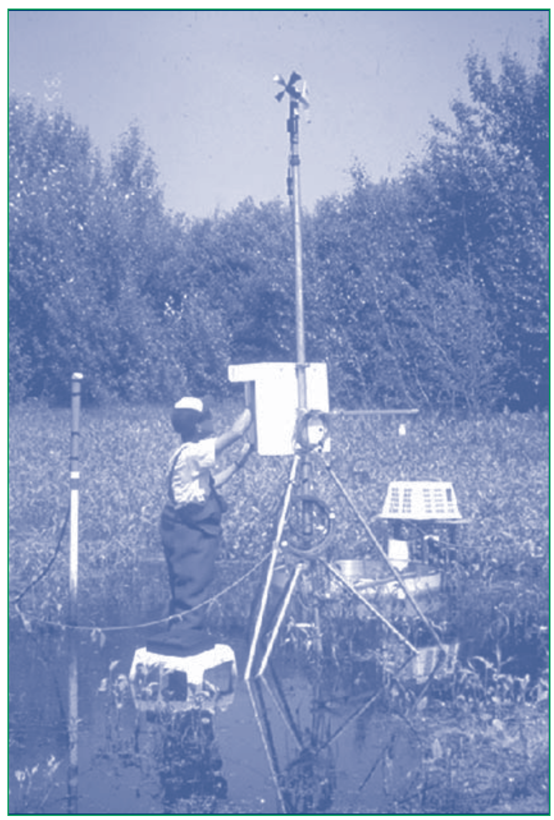
Long-term data collected since 1968 show that almost every year water levels in the sloughs are highest at the end of snowmelt, and recede during the summer due to evaporation. The data also show that water levels fluctuate from year to year as a result of wet and dry cycles. For example, in 1997 water levels were at their highest point since 1968, yet in 2002 they are at their lowest—with only the deepest slough in the area still holding water.

While investigating these water balances, the research team discovered a startling phenomenon. Between 1980 and 1983 about one-third of the 4km^2 wildlife area had been converted from cultivated fields to a permanent cover of brome grass to reduce erosion and provide better nesting cover for waterfowl. A few years after this conversion, all the wetlands in the brome grass area dried out and have remained dry since. Yet, wetlands in adjacent cultivated lands continue to hold water, as before.

After measuring snow accumulation, soil moisture and vegetation height, and carrying out water-infiltration tests, researchers determined how the brome grass had reduced water input to the wetlands. Over a few years, the undisturbed soil in the grassed areas has developed a network of cracks and root holes that allow water to infiltrate the soil, even while it is frozen. As a result, much of the water that would normally flow to the slough during runoff is, instead, absorbed on route. In contrast, any cracks in the soil in adjacent fields are regularly broken up by cultivation, so it is less permeable when it is frozen.

These findings have important implications for agencies involved in wildlife conservation and habitat management, because they imply that the introduction of dense nesting cover for ducks could actually lead to the disappearance of prairie wetlands. As such, researchers continue to assess the hydrologic effects of such efforts, and are investigating whether the use of zero or minimum tillage or the expansion of trees into and around wetlands would have a similar impact.

In related work, the scientists are also carrying out an examination of how and why small "sheet-water puddles" occur in prairie fields in the spring, and recently began work to document the carbon-sequestration potential of the wetlands and their sensitivity to climate change. Together, these efforts will provide the information needed for the sustainable management of these small yet vital aquatic ecosystems. S&E



An NWRI researcher measures evaporation from a small wetland in the St. Denis National Wildlife Area in Saskatchewan.

PLANE FACTS IMPROVING FORECASTING

A fleet of turboprop airplanes used for short-range passenger flights in eastern Canada is improving the accuracy of Environment Canada's weather forecasts by giving meteorologists a better look at the structure of the lower atmosphere.

The 21 Dash-8s, which are owned and operated by Air Canada Jazz, are the heart of Canada's new Aircraft Meteorological Data Relay (AMDAR) Program. The program collects data on atmospheric pressure, temperature and wind from aircraft sensors and navigational, processing and communications systems and transmits them to the department's Meteorological Service of Canada (MSC) in near-real time.

MSC's current network of 31 upper-air stations provides twice-daily profiles of the atmosphere using weather balloons, satellites and ground-based instruments. Each of the 21 AMDAR-equipped planes adds two profiles per flight to the total, a significant boost given that many of the planes make up to eight flights per day.

Such additional information is vital to modern forecasting, as advanced numerical prediction models require observations at a much finer scale in space and time. Because they serve smaller and more northerly communities, the Dash-8s also provide data in remote areas where coverage is typically scarce.

The program is also very cost efficient. Working closely with Air Canada Jazz to incorporate AMDAR requirements while the airline was still establishing its air-ground data-link program enabled Environment Canada to keep software development and installation costs low. Per profile, the operating cost is less than one per cent of that of an upper-air station.

The AMDAR software directs sensors on the aircraft that already collect and report meteorological data for in-flight operations to do so more frequently. During ascent, when the plane is climbing through layers of air, the rate begins as once every six seconds—giving forecasters a snapshot of atmospheric conditions every hundred metres. It slows to once every three minutes when the plane reaches cruising altitude, and then speeds back up to once a minute during descent.

Data fed into the aircraft's communications and reporting system are transmitted to the ground by radio signal and picked up by a network of antennas connected to the airline's operating centre. There the weather data are removed from the other communications data and sent to the Canadian Meteorological Centre in Dorval, Quebec, for processing. The results are used to create regional forecasts and other specialized products, including forecasts for the aviation industry.

The data are currently being assessed, and once validated will be made available to the international meteorological community through the Global Telecommunications System. Canada expects to add some 10 000 observations to the approximately 150 000 reported daily—most of which come from the United States, Europe, Australia and New Zealand.

An Air Canada Jazz Dash-8 aircraft carrying the AMDAR system.

The quality of forecasts produced using AMDAR data will enable the aviation industry to improve its flight planning to reduce fuel consumption, avoid unscheduled stops, and take advantage of the strength and direction of prevailing jet streams. European forecasters will also benefit from the improved forecasts in eastern Canada, since weather systems take approximately two days to cross the Atlantic Ocean.

Shortcomings of the program include the fact that the troposphere—the critical region of the atmosphere where weather occurs—extends to about nine kilometres above the surface of the earth, while Dash-8s fly at altitudes of only five to seven kilometres. As such, scientists are already looking at expanding the program to include small, higher flying jets. Also, unlike weather balloons, the Dash-8s are not equipped with water-vapour sensors, which are useful in determining the formation of clouds and thunderstorms. It is expected, however, that such technology will be operational within five years.

By the end of 2004, AMDAR will be aboard all 63 Dash-8s in the Air Canada Jazz fleet, giving the program virtually cross-Canada coverage in the southern latitudes. Environment Canada plans to increase this coverage by adding other air carriers eventually, and has already signed a contract with First Air to develop and implement an alternative system for the north within three years.

The more timely and accurate weather forecasts resulting from this program will not only help to safeguard the health and safety of Canadians, but also give our aviation, tourism, and other weather-dependent industries a critical competitive edge. S&E

A DECADE OF PREACHING SAFE SUN

Ten years after it was first introduced to remind people about the health hazards of overexposure to the sun, Environment Canada's UV Index has become a part of daily forecasts in over two dozen countries around the world.

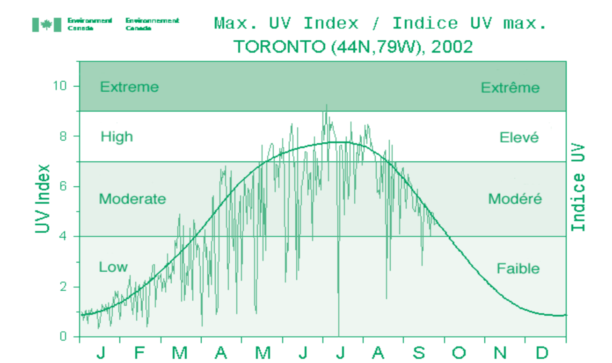
A recent poll shows that 55 per cent of Canadians use the index, which uses a numerical scale to indicate the maximum ultraviolet (UV) radiation predicted for the day. Although the highest value ever measured in Canada was 10.1, the upper limit of the scale is a scorching 300—or the amount of UV one would encounter in space, beyond the earth's atmosphere.

The index is predicted from weather patterns and measurements of stratospheric ozone, a colourless gas that is a close chemical relative of molecular oxygen. Although ozone has different effects at ground level, in the stratosphere it absorbs UV radiation, acting as a protective layer between the sun and the earth's surface. Environment Canada takes stratospheric-ozone readings from sun-up to sundown at 12 weather stations from the High Arctic to southern Ontario.

The readings are made with the Brewer ozone spectrophotometer, a sophisticated instrument developed by Environment Canada that measures the intensity of UV radiation falling on a horizontal surface. An index reading of 1 to 3 is low, 4 to 6 is moderate, and 7 or above is high.

Complacency about the harmful effects of the sun is still common. Because the sun's rays provide warmth and light, and small amounts of exposure have such beneficial effects as the production of vitamin D, people often overlook the fact that too much exposure can cause skin cancer, cataracts and other serious health problems.

The sun's double-edged sword stems from the fact that it produces radiation of different wavelengths. At the long end of the solar spectrum is infrared radiation (heat), followed by visible light—which ranges from red to violet. Beyond violet is invisible ultraviolet (UV) radiation, then x-rays and gamma rays.



Maximum UV Index readings for Toronto from January to September 2002.

Radiation is most harmful to animal and plant life at wavelengths shorter than 320 nanometers, which is the middle of the ultraviolet range. Of the three bands of ultraviolet radiation, UV-A is the longest and behaves much like visible light. UV-C is the shortest but is filtered out by the atmosphere before it reaches the earth. UV-B is between the two and falls on the surface of the planet in significant quantities—making it the biggest threat to human health.

The amount of UV-B that reaches the earth depends on the amount of ozone in the stratosphere. Since the late 1970s, the ozone layer has been thinning due to the release of certain ozone-depleting chemicals, such as chlorofluorocarbons. In southern Canada, ozone has thinned by an average of six per cent. In the Arctic and Antarctic, ozone losses have been up to 45 and 70 per cent respectively during spring, when the chemical processes that destroy ozone are most active.

One major factor that determines the quantity of UV radiation on the earth's surface is the angle of the sun. The higher the sun is in the sky, the less atmosphere it has to go through and therefore the less radiation it loses through absorption and scattering. That's why daily values of the UV index generally peak at solar noon. UV radiation is stronger near the equator and varies more at mid-latitudes according to the time of year. For example, in Canada, the UV Index averages between 1 and 2 in the winter, while in the summer, the values are usually between 7 and 9.

There are other factors affecting the quantity of UV at the earth's surface. These include clouds that can filter out 50 to 75 per cent of UV radiation by reflecting it back into space, and airborne particles, or aerosols, which both absorb and scatter radiation. UV values are enhanced at higher altitudes where the air is cleaner and thinner and by snow which reflects radiation upward.

With global efforts on track to eliminate ozone-depleting substances by 2005, scientists are hopeful that the ozone layer will be able to repair itself in 50 to 100 years. Until then, the UV Index will continue to provide people with the information they need to protect their health by reducing the amount of time they spend in the sun, using sunscreen, and wearing sunglasses and protective clothing when they are outdoors. S&E

WHAT GOES UP...

A team of scientists gathered in a Saskatchewan field on a still September night to release what looked like a giant jellyfish into the jet-black sky. Hours later, what was actually a gargantuan research balloon was floating 40 kilometres above the earth, measuring ozone and ozone-depleting substances in the atmosphere.

The MANTRA balloon being prepared for launch.

The unmanned MANTRA research balloon, which is as tall as a 25-storey building and made of transparent polyethylene, carried over 600 kilograms of equipment into the stratosphere on its 24-hour flight. An important addition to the balloon's payload was Environment Canada's MAESTRO—a state-of-the-art instrument that will go into space aboard the new SCISAT-1 satellite early next year to study the ozone hole over the Arctic.

MANTRA (Middle Atmosphere Nitrogen TRend Assessment) is a collaborative effort involving Environment Canada's Meteorological Service, the Canadian Space Agency, and industry and university partners. In addition to validating the performance of the balloon's payload, its purpose is to help researchers determine the effectiveness of actions taken under the Montreal Protocol, an international treaty that calls for the total elimination of ozone-depleting substances by the year 2005.

The launch took place in central Saskatchewan in September because of the relatively low variation in ozone levels over the mid-latitudes at that time of year. This means that satellite observations made within a day or so of the flight can be used to validate the results. The 2 a.m. launch meant calm winds and an opportunity for the instruments to take measurements of the vertical profiles of atmospheric constituents during sunrise.

The balloon was inflated using helium to only 0.5 per cent of its capacity at the time of the launch, but eventually expanded 200 times due to the lower atmospheric pressure at high altitude. When it reached its designated float height of 37.6 kilometres, vents near the bottom of the balloon allowed excess gas to escape.

Data collection continued until shortly after sunset. Using the Global Positioning System on the balloon and a computer model, researchers on the ground determined approximately where the payload would land if it were released. When conditions were right, the steel cables attaching the payload to the balloon were severed remotely using explosive cutters, and the parachute was opened. Both the equipment and the deflated balloon were retrieved safely.

Analyzing the data collected by the MANTRA instruments could take years, although scientists hope to have some preliminary results within a few months. The readings taken on this flight will be added to the string of data collected on balloon flights since 1974—before the ozone layer showed signs of depletion. Next year, more data will be added after MAESTRO and the other MANTRA instruments go into the stratosphere again to provide validation data for the SCISAT-1 after its launch early in 2003.

Chlorofluorocarbons and other ozone-depleting substances are responsible for about 50 per cent of ozone loss. Although reductions in these substances have already been seen in the lower atmosphere, MANTRA's data will help to indicate if such changes are now occurring at higher altitudes. Scientists suspect that by increasing stratospheric cooling, climate change may be accelerating the chemical processes that destroy ozone. MAESTRO's venture into space is expected to shed some light on these and other mysteries. S&E

S&E Bulletin

This bi-monthly newsletter provides information on Environment Canada's leading-edge science and technology.

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Scientific contacts may be obtained from the *Bulletin*'s editor at Paul.Hempel@ec.gc.ca, or (819) 994-7796. Comments and suggestions are also welcome.