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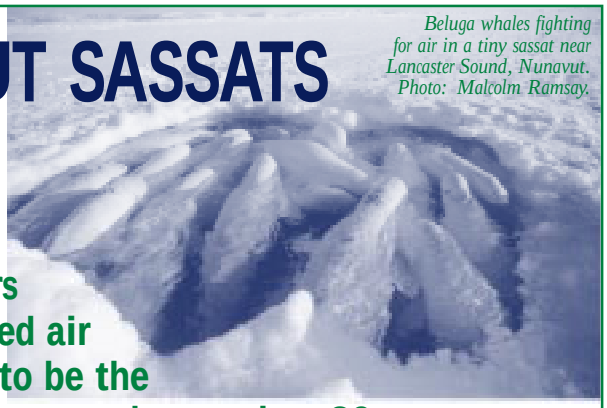
BREAKING THE ICE ABOUT SASSATS

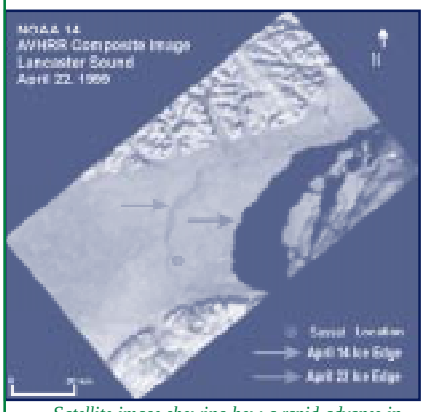


Beluga whales fighting for air in a tiny sassat near Lancaster Sound, Nunavut. Photo: Malcolm Ramsay.

In the spring of 1999, a University of Saskatchewan biologist tracking polar bears on Lancaster Sound, north of Baffin Island, discovered a group of more than two dozen bears gathered around a cluster of swimming pool-sized air holes in the solid sea ice. The holes turned out to be the only lifelines for some 75 whales that had been trapped more than 30 kilometres from open water by a sudden advance in the ice edge.

Although the Inuit have long known about this unique polar phenomenon, which they call a sassat, the entrapment of whales in Arctic sea ice is rarely witnessed because the air holes are so difficult to spot — especially from the air. The events appear to take place in early spring, when whales enter areas of unconsolidated or loose pack ice in search of food. Because ice concentrations in these packs are already about 80 per cent, certain conditions can cause them to solidify or consolidate very quickly, leaving the whales stranded without sufficient breathing holes to reach the open ocean. Forced to enlarge existing holes and remain there until the ice breaks up, they become easy prey for polar bears and Greenland sharks.

Last fall, the University approached Environment Canada's Canadian Ice Service to help determine precisely when the Lancaster Sound sassat occurred and to identify the conditions that cause late season ice-edge surges. The collaboration is an important step toward understanding how frequently these events occur, and the mysterious relationships between ice-associated animals and sea ice conditions. By understanding these linkages, scientists hope to determine the potential repercussions of climate change on sea ice formation and animal populations. For example, if global warming causes sea ice to begin melting earlier and forming later, polar bears may have less time to forage for food, but might benefit from increased opportunities for sassats.



Satellite image showing how a rapid advance in the ice edge trapped the whales some 30 kilometres from open water.

Using satellite imagery collected for the operational ice forecasts they provide to the shipping industry, ice experts narrowed the date of the sassat down to three or four days in mid-April by monitoring changes in the ice edge. Additional meteorological information helped them pinpoint April 16 as the most likely date of the event, because that was when a high pressure system brought very cold temperatures and winds from the northeast, which pushed the unconsolidated pack ice up against the ice edge. They estimate that the ice advanced about 30 kilometres in less than 48 hours, and that the sassat lasted about 60 days.

As the first sassat studied by Canadian biologists, the Lancaster Sound event yielded some interesting information. Four bears tranquilized at the site proved heavier than the heaviest specimens ever measured in their age and sex classes in more than 10 years of study — proving that the bear exploit this phenomenon heavily and in a short period of time. The whales were also significantly affected, with a number badly injured or killed as a result of attacks suffered from below and above, as they surfaced to breathe. Although the whales represented less than one per cent of the local beluga population, the potential impact of several events each year could be significant. Of even greater concern is the fact that one of the whales involved was an endangered bowhead. Observations made at the site also offered the first evidence that Greenland sharks prey on live whales.

This spring, ice scientists have stepped up their monitoring of the ice edge and meteorological data to identify potential entrapment conditions — including calm conditions with very low temperatures, and storms that break up the ice edge, making it possible for it to re-consolidate later. They also plan to examine the conditions surrounding a similar incident near Grise Fiord, 100 kilometres north of Lancaster Sound, that also occurred in the spring of 1999. By using their knowledge of how, when and why sea ice forms to assist biologists in locating sassats for further study, Environment Canada's ice scientists are greatly improving our understanding of the biological significance of this little-known phenomenon. S&E

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KNOWLEDGE OF ALPINE WEATHER AT A PEAK

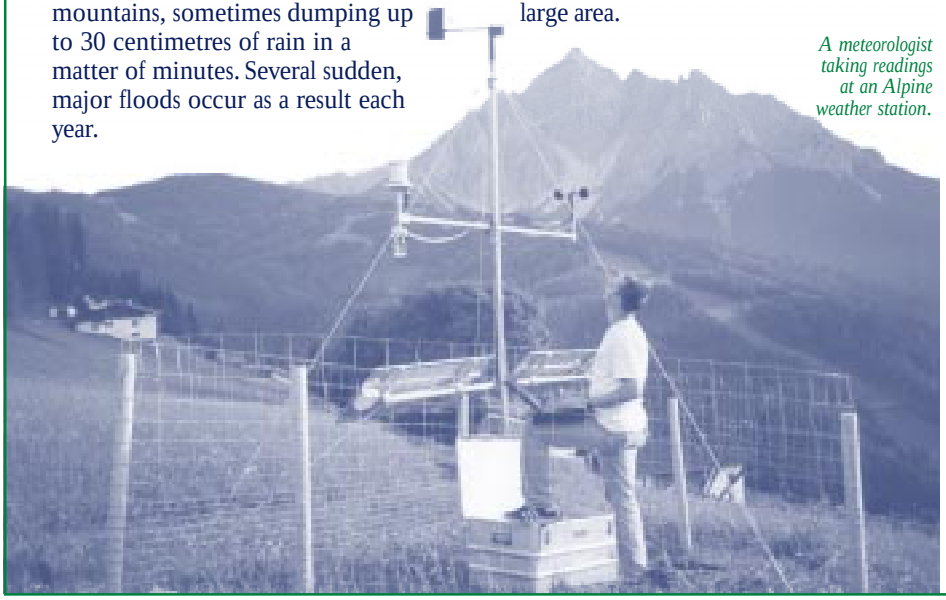
As hikers, skiers and pilots know from experience, alpine weather can be both extreme and unpredictable. For reasons that are still little understood, the topography of the world's mountainous regions can cause sudden, violent meteorological conditions — from gusting winds and clear air turbulence to hailstorms and torrential downpours. These conditions can trigger flash floods, landslides and avalanches, and pose hazardous in-flight conditions for aircraft.

To learn more about the mechanics behind these systems and to improve the understanding and prediction of alpine precipitation and flooding, more than 200 scientists from Canada, the United States, Britain, France, Germany, Austria, Italy, Switzerland and Slovenia spent 10 weeks in the European Alps last fall as part of the decade's largest and most sophisticated mountain weather experiment. Known as the Mesoscale Alpine Programme, it focused on weather systems that are 10 to 100 kilometres across — the ones that carry weather conditions you can feel, such as thunderstorms, hail and snow.

The Alps were chosen not only because they have more meteorological instrumentation than any other area of the world, but also because of the profound influence they have on regional weather. Most natural disasters in the Alps and the surrounding area are caused by alpine precipitation. Conditions peak in the fall, when warm air from the south absorbs moisture as it passes over the Mediterranean Sea and then cools suddenly over the mountains, sometimes dumping up to 30 centimetres of rain in a matter of minutes. Several sudden, major floods occur as a result each year.

Three regions were equipped with additional weather stations and measurement instruments and monitored by instrumented research aircraft: part of Germany's Rhine Valley and Austria's Wipptal Valley, and the Lago Maggiore region of Italy. A team of Environment Canada meteorologists were stationed at project headquarters in Innsbruck, Austria, to provide detailed hourly weather forecasts using an ultra-high-resolution software they have been developing over the past eight years.

The MC2 software, which was run on a Swiss supercomputer, collected data in real time from across the entire Alpine massif, from Lyon to Vienna. More than once a minute, the program updated information from thousands of points exactly three kilometres apart on a horizontal grid 1 000 kilometres square. Readings for each of these points were taken at 50 different atmospheric levels (twice that of a normal forecasting model), making it the first time such a fine mesh has been used to forecast conditions over such a large area.

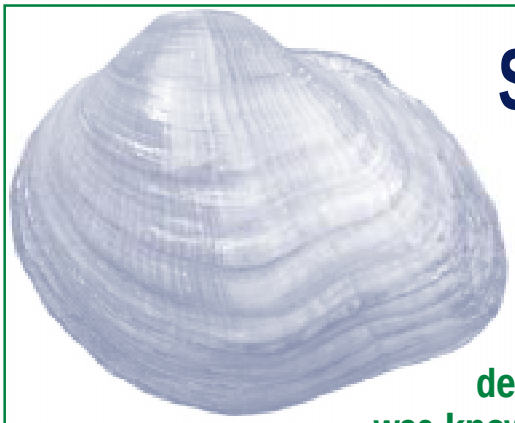


A meteorologist taking readings at an Alpine weather station.

The detailed meteorological and topographical information collected using specialized instruments and research aircraft, coupled with the real time simulations carried out by the MC2, made it possible for the forecasters to detect even minute changes in cloud content and air movement, and forecast the strength of wind, precipitation and other weather parameters in the region to an unprecedented degree of accuracy. They were able to pinpoint the location of dangerous storms to within a few kilometres, and determine several hours in advance when they would start and stop. The state-of-the-art supercomputing technology used by the MC2, however, proved very expensive to use routinely over such a large area.

A second objective was to study and forecast gravity waves caused by changes in the density of the air. These highly localized oscillations often occur over mountainous terrain, and can cause extreme air turbulence for aircraft when they reach their peak amplitude and break, like ocean waves. Although the MC2 proved adept at calculating the strength of these oscillations, it had difficulty determining when they would break, although simulations over a smaller area on an ultra-fine one-kilometre grid improved the model's success rate significantly.

Scientists estimate that it will take about five years to analyze and interpret the more than 10 gigabytes of new forecast data collected daily over the course of the experiment, but their first early results will be presented at a meeting in Slovenia this June. This work will greatly improve the understanding and forecasting of hazardous alpine weather conditions and, as a result, the safety of people and property in mountainous regions around the world. S&E



SAVING CANADA'S ENDANGERED MUSSELS

Freshwater mussels are among the most endangered organisms in North America. Over the past century, researchers in the United States have reported severe declines in mussel diversity and abundance, but little was known about their status in Canada until recently. Now, a clear picture of what is happening to mussels in the lower Great Lakes drainage basin is beginning to emerge, and work is in progress to protect them.

North America has the greatest diversity of freshwater mussels in the world, with nearly 300 species. These invertebrates are particularly vulnerable to the effects of human activities because of a unique feature of their life cycle. Once their young have reached the larval stage, female mussels expel them into the water where they must attach to the gills or fins of a host fish to complete their development. This puts mussels at risk not only from environmental disturbances that affect them directly, such as habitat destruction, sedimentation and pollution, but also from those that affect their host fish.

The introduction of the zebra mussel to the Great Lakes in recent years has led to catastrophic consequences in an area that once boasted the most diverse and unique mussel fauna in Canada. Zebra mussels attach to the shells of native mussels, thereby interfering with their feeding, respiration, and burrowing. Populations of native mussels in Lake St. Clair, western Lake Erie, and the upper St. Lawrence River have been devastated.

In 1994, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) included invertebrates in its mandate for the first time, with molluscs one of the first two groups to be considered. This set the stage for researchers at Environment Canada's National Water Research Institute (NWRI) to launch a major effort to investigate the changes that have occurred in the composition of freshwater mussel communities in the lower Great Lakes drainage basin over the past century, and to identify species at risk.

Researchers gathered over 4 000 records taken between 1860 and 1996 on 40 species at 1 500 sites and entered them into a computerized database. The records came from a variety of sources, but primarily from six natural history museums in the Great Lakes area. Among the 200 investigators whose work was brought together for the first time were museum curators, graduate students, research scientists and 19th-century amateur naturalists.

When they analyzed the data, researchers discovered a pattern of species loss and changes in community composition throughout the basin, with displacement of many unique and ecologically fragile species by fewer pollution-tolerant species. The results of their work provided compelling evidence that the steady decline in mussel diversity already documented in the United States was also happening in Canada.

Researchers embarked on a risk-factor analysis to identify the species most at risk and to prepare a list of candidate species to be considered by COSEWIC for national status designation. A series of field studies conducted in various rivers in the research area in 1997-98 showed that the situation might not be as grim as originally thought. In the Grand River, which runs from Kitchener to Lake Erie, mussel populations appear to have rebounded, perhaps due to improvements in water quality resulting from better sewage treatment. The Sydenham River, in the southwesternmost tip of Ontario, was discovered to have the most diverse and intact mussel community of any of the rivers investigated, and probably of any in Canada, and is a major refuge for many rare species.

Identifying and measuring mussels on the shores of the Thames River in southwestern Ontario.

In 1999, based on NWRI's status reports and recommendations, COSEWIC designated three mussel species as endangered. Now, with funding from several sources, work is in progress to develop recovery plans to protect and restore mussel communities in the Great Lakes basin. Once the disturbances threatening the health of mussel communities have been identified and resolved, species can be restored by stocking with lab-reared specimens, augmenting small populations with specimens from larger populations, and reintroducing mussels back into their restored historic habitat. SOE

Evironment Canada scientist Peter Hennigar collecting mussels at Digby, Nova Scotia, as part of the Gulfwatch monitoring program.

SCIENTISTS PUT MUSSELS INTO MONITORING

The succulent blue mussels so many restaurants serve steamed with a wedge of lemon are being used by Environment Canada scientists in the Atlantic region to gauge levels of toxic chemical contaminants in the briny waters of the Gulf of Maine.

Mussels are an ideal indicator species not only because they are abundant and easy to collect, but also because they feed by pumping large volumes of water through their systems, exposing their tissue to contaminants in the process. Because mussels remain fairly stationary over the course of their lives, scientists can determine water quality in a specific area simply by analyzing the concentration of contaminants in the tissue of native mussels.

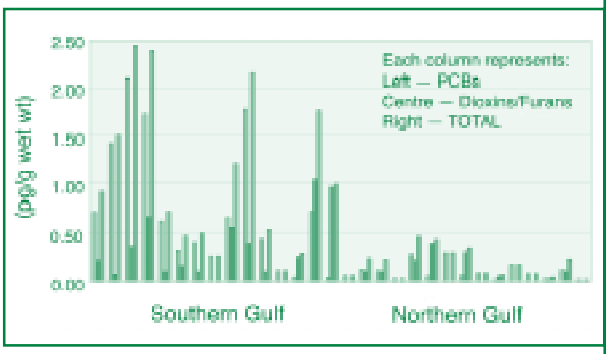
The Gulf of Maine is one of the most productive ecosystems in the world. Extending from Cape Sable, Nova Scotia, to Cape Cod, Massachusetts, and including the Bay of Fundy and Georges Bank, it supports a vast array of seaweeds, salt marsh grasses, phytoplanktons and marine animals, including many species of commercial importance. Unfortunately, human population growth and land development have dramatically increased the release of atmospheric and effluent pollution into the Gulf's coastal and estuarine environments over the past 50 years. Of particular concern are persistent toxic substances like polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, dioxins and furans, and trace metals, because they bioaccumulate in tissue and can magnify to biologically harmful levels in the food chain.

To protect the health of the species in the ecosystem, including the humans who consume its seafood, the Gulf of Maine Council on the Marine Environment established the transboundary Gulfwatch monitoring program. Since 1991, Environment Canada scientists and other members of the Canada/US Gulfwatch Monitoring Committee have headed to the shores of the Gulf each fall to hand-pick some 200 mussels at each sampling site — most located at the mouths of river watersheds and on coastal drainage systems. Samples are native mussels, but some clean transplants are also collected to evaluate the effects of short-term exposure to the Gulf waters. Five benchmark sites in Nova Scotia, New Brunswick, Maine, New Hampshire and Massachusetts are sampled annually, with the remaining 56 sites sampled once every three years on a rotating schedule.

Results have shown that concentrations of toxic organic contaminants and silver increase from north to south. Lead and chromium concentrations were elevated at sites within Massachusetts, New Hampshire and Maine. Other trace metals show a relatively uniform geographical distribution. Generally, contaminant concentrations were correlated with population density, latitude and distance from known contamination sources.

Very few sites have mussel tissue contaminant concentrations that exceed Canadian or American seafood human health tolerances; however, some have levels that require a more in-depth assessment of human health risk, and several exceed tissue concentrations considered harmful to birds and other wildlife. An examination of changes in data over time indicates that contamination levels at most benchmark sites are either decreasing or show no detectable change.

Government agencies in Canada and the United States use this information for a variety of purposes: to develop environmental management plans and policies, licensing requirements for industrial discharges, and pollution controls; to determine the safety of seafood; and to assess the effects of accidental spills and other specific events on water quality. Shellfish and fish aquaculturists use Gulfwatch data to find clean areas for harvesting and growing facilities.



Graph showing concentrations (2,3,7,8-TCDD TEQs) of PCBs and dioxins/furans found in mussel tissue at Gulf of Maine sites in 1996 and 1997.

Gulfwatch has recently begun collaborating with community-based environmental organizations to address local concerns about other toxic substances, including chemicals used by the aquaculture industry to kill parasites. Researchers hope that as public awareness about the impacts of toxic contamination grows, the use of these and other potentially harmful substances in this prolific ecosystem will decline. SOE