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CLIMATE CHANGE AND WILDLIFE

Of all the ways in which human activity affects the distribution and abundance of wildlife on our planet, none is as pervasive and powerful as climate change. If carbon dioxide concentrations double over the next century, as scientists predict, virtually every place on earth will see changes in the health and variety of local plants and animals.

According to global climate models, the future will bring increases in surface temperatures, precipitation and the frequency of severe weather events, as well as a rise in sea level and a decrease in sea-ice cover. How these changes—and others they cause in turn—will affect wildlife is difficult to predict. Some species will adapt, some will move to new areas, and some will gradually die off and be replaced by others that are better adapted to the new conditions.

All species have a capability to adapt—at least to some degree—to natural stresses. Changes to climate and habitat have been occurring for eons, and with them have come changes to the diversity of species on earth. What makes current climate change unique is that, with the exception of cataclysmic events such as meteor strikes, the rate at which it is taking place is leaving species and ecosystems no time to adapt.

According to a 2002 report by the World Wildlife Fund (WWF), entitled *Habitats at Risk: Global Warming and Species Loss in Globally Significant Terrestrial Ecosystems*, many habitats may change ten times more quickly than they have since the last ice age. This means that species will have to either adapt or shift their ranges at a rate faster than they ever have in the past in order to roll with the climatic punches: for many, an unrealistic expectation.

If sea ice disappears over the next century, as climate models predict, polar bear populations would be decimated or possibly even wiped out.

Particularly vulnerable to extinction are species that require different habitats at different stages of their lives, such as amphibians, and those for which habitats are specific and physically restricted to small areas. Included in this latter group are animals and plants that live on islands, in isolated lakes, or in the upper regions of mountains and have nowhere else to go if their habitat slowly becomes uninhabitable. Migratory birds, such as shorebirds, that rely on flushes of food at various staging or breeding sites are also at great risk.

The WWF report echoes the predictions of the Intergovern-mental Panel on Climate Change, the U.S. National Wildlife Federation, and other scientific authorities that climatic changes will be most severe at higher latitudes and altitudes. It says Canada will be among the countries hardest hit by the effects of climate change, and cites two biologically rich areas in Canada's north—the low Arctic tundra and the Muskwa/Slave Lake boreal forests—as among the most vulnerable ecosystems in the world.

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The main reason that higher-latitude ecosystems will be more stressed is that surface warming in Arctic regions is expected to be significantly higher than elsewhere. Since much of the north is covered in snow and ice, global warming will have a devastating impact on this highly specialized wildlife habitat. Adding to the stress on northern ecosystems is the fact that the geographic ranges of plant and animal species are expected to shift northward and upward in altitude, thereby increasing competition with pre-existing species for food and space.

Muskoxen on tundra.

Scientists have already observed changes in species ranges and patterns of distribution with the gradual increase in surface temperature over the past 50 years. In North America, the range of certain insects, including butterflies and spiders, has expanded northward—and some bird species have begun their spring migrations and breeding earlier. Fish are also highly sensitive to changes in temperature, and many warm-water species have been seen further north in recent years.

Vegetation is also migrating northward, with most climate change scenarios suggesting that the climatic zone suitable for boreal forests could be displaced as much as 550 kilometres northward over the next century. The reason for this migration is that warmer temperatures cause deeper seasonal thawing, which, in turn, improves soil drainage and stimulates the release of nutrients. Heat from the sun also promotes litter decomposition and stimulates plant growth.

While this will mean increased food availability for herbivores, vegetative changes will lag behind climate change, particularly when it comes to trees. In the interim, as trees and other plants die off and gradually establish themselves elsewhere or are replaced by other species, many birds and animals that relied on the original habitat will be left with nowhere to turn. Disrupted habitats such as these also favour a less diverse, more "weedy" vegetation, and are more easily invaded by alien species.

In the Arctic, expectations are that the tundra will shrink by as much as two thirds, as other plant species move in to replace native vegetation. This would have a major impact on the world's shorebirds and polar species—many of which rely on this habitat during long migrations or to feed their young. Muskoxen and barren-ground caribou are very dependent on access to tundra vegetation, with lichen making up roughly 60 per cent of the latter species' diet.

As the tundra disappears, barren-ground caribou will also likely shift northward, eventually invading the territory of the smaller Peary caribou found in the High Arctic Islands. Although milder winters could enhance the reproductive capacities of caribou and other species, if predictions of increased precipitation are correct, heavy winter snows could also force them to expend more energy feeding and even prevent them from getting to their food. If the snow cover melts into slush, or is softened by rain, it could also freeze into solid ice, making it impossible for the caribou to graze over much of their range. Ice-layered snow may also trap carbon dioxide in the burrows of small mammals, such as hares, and either poison them or force them to the surface, where they are at greater risk of predation or freezing. Significantly warmer weather will also likely increase the kinds and incidences of diseases and parasites in the High Arctic.

Warmer temperatures could also create other problems for animals by causing changes in the timing and extent of sea-ice cover. Earlier break-up of freshwater ice on lakes and rivers in spring could affect migration patterns, and increase the likelihood of animals being drowned as they attempt to reach their seasonal feeding grounds—a phenomenon that already occurs in years when such early break-ups take place. They also affect animals like polar bears and seals, which rely on the ice for other essential purposes.

In western Hudson Bay, sea ice is breaking up an average of two weeks earlier than it did 20 years

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ago. This has shortened the period of time that polar bears have to hunt on the ice before it melts completely by mid-July. Since the bears in that area are then forced onto land to fast for at least four months (pregnant females for eight), fat stores built up during the hunt are crucial to survival and the production of cubs. Studies by Environment Canada scientists of adult males and females over the same 20-year period have shown a direct correlation between early ice break-up and a decline in the bears' condition, as well as declines in reproduction and mean litter size. If sea ice disappears completely by 2100, as climate models predict, scientists say few or no polar bears will be left in the area.

Ringed seals, the bears' primary prey, are also affected. A study of the seals in the Amundsen Gulf found pups were being abandoned or dumped in the open water by their mothers when the ice broke up early. Walrus and bearded seals also require strong sea ice as platforms for breeding, raising pups and resting. Female ringed seals use snow that has drifted over breathing holes in the ice to create birthing dens in the spring. As was witnessed several years ago on Baffin Island, unseasonably early rain can cause these dens to collapse and wash away, exposing pups to predation by polar bears and arctic foxes.

Reductions in sea-ice cover also mean changes in extent and location of ice edges and open water. Plankton thrive in this region of the marine ecosystem, and support a large population of fish, which provide food for a variety of marine birds and mammals. Changes in water temperature, ocean currents and ice cover are expected to cause a northward shift in the range of many marine species and, as such, a shift in the availability, type and location of food.

Environment Canada scientists have been using colonial seabirds as indicators of the kinds of changes arctic marine ecosystems are undergoing as a result of global warming. Studies of Thick-billed Murres in breeding colonies in northern Hudson Bay between 1980 and 2001 have shown that the nesting diets of chicks have shifted dramatically during this period. Arctic cod and sculpin—once the primary foods of the young murres—now make up a significantly smaller portion of the chicks' diet, while capelin and sandlance make up a much larger part.

The scientists say the change is evidence that the reduction in ice cover in Hudson Bay during the nesting season—the cover has halved over the past 30 years—has altered the relative abundance of these species in the waters of the Bay. Arctic cod, a key species in the arctic marine food chain, relies on ice cover for foraging and to escape predation; capelin and sandlance, on the other hand, are more typical of subarctic waters. Highly sensitive to changes in water temperature, the capelin has also undergone major changes in population and distribution in the waters off Atlantic Canada since the 1980s.

The study also found evidence to support the theory that warming makes ecosystems more vulnerable to insect and other pests—a phenomenon that could have a severe impact on animal populations. The scientists noticed that increased temperatures in northern Hudson Bay have caused mosquitoes to emerge earlier in the season, resulting in the heavy blood-sucking of incubating birds. The situation, which had never been witnessed before, resulted in some birds literally allowing themselves to be sucked to death, an indication that the problem was not one the birds had been exposed to previously. Others simply abandoned their eggs and flew to sea—a behaviour they would normally never exhibit. As a result, losses of murre eggs to gulls were three to four times higher on days when large numbers of mosquitoes were present.

Thick-billed Murres.
Photo: Tony Gaston.

The earlier emergence of mosquitoes and other invertebrates as a result of warming could also cause problems for shorebirds that breed in the Arctic. Newly hatched larvae are the primary prey of shorebird chicks, so in order to hatch their clutches before peak insect emergence, adult birds will have to migrate north earlier and earlier. This may not be possible if, as expected, the timing of the laying of horseshoe crab eggs in Delaware Bay changes more slowly, because the crabs are essential prey for many shorebirds during spring migration. Environment Canada scientists are currently working to determine whether large population declines found in many species of shorebirds breeding in the eastern Canadian Arctic are linked to changes in summer climate.

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Although Arctic ecosystems are expected to be the hardest hit, others in more southern regions of Canada will also be affected by climate change. Fish off both coasts and in rivers, lakes and streams are expected to react—cold-water fish by heading north, where possible, and warm-water fish by moving into habitats that were previously too cold for them. In southern Ontario, black bass, white bass and sunfish are among those expected to thrive as the water warms, while lake trout and whitefish could disappear. Pacific salmon living off the coast of southern British Columbia could move their range northward if waters continue to warm, while tuna and mackerel take their place.

Shorebirds that breed in the Arctic, such as the Semipalmated Sandpiper, are particularly vulnerable to the effects of climate change. Photo: C. L. Gratto-Trevor.

Both the Atlantic and Pacific coasts will see a rise in sea level if warming continues, with a resultant increase in coastal erosion and flooding, and a loss of coastal wetlands. Higher sea levels could damage important nesting sites, eggs and chicks, particularly if the frequency of severe storms increases as climate models suggest. Tidal marshes in British Columbia's Fraser Delta, which are critical habitats for waterfowl, shorebirds and salmon fry, could be drowned or crushed against sea dikes.

Changes in river and stream runoff, due to less snowpack, an earlier ice break-up, a stronger spring flow, and a reduced summer flow, will greatly affect aquatic ecosystems. Lower water levels in rivers, lakes and wetlands threaten the abundance and reproduction of both fish and waterfowl, and have already been witnessed in many southern regions of the country. Extremely low water levels observed on the freshwater portion of the St. Lawrence River in 1998-99 caused significant changes in habitat, and allowed the invasion of opportunistic vegetation.

In mountainous areas where glacial meltwater helps preserve habitat for trout and other species that are highly adapted to cold water, lower flows could have a strong impact on these species' ability to migrate and spawn. Reductions experienced in recent years may already be having a serious impact on the bull trout population.

Despite projected increases in precipitation, scientists expect there to be a decrease in water availability in many southern regions of the country—particularly the prairies—due to increased evaporation caused by warming. This will exacerbate water level problems in aquatic ecosystems such as wetlands and marshes, and may cause some to dry up completely. The loss of such areas would have a major effect on waterfowl, shorebirds and other species that depend on them.

Fire regimes are expected to change in most of Canada's boreal region, affecting forestry practices and habitat available to wildlife. Moreover, as temperatures increase, crops such as wheat can be grown farther north, resulting in further losses of habitat.

There is no way of knowing for certain how wildlife will respond to the changes in habitat that will be induced by the current, rapid rate of climate change. However, ongoing studies by Environment Canada scientists and others of recent alterations in the behaviour, distribution and abundance of species are sharpening our picture of the future. These studies provide crucial evidence that, unless we take immediate and drastic steps to mitigate climate change, our global biodiversity may be altered irreversibly within a century.

Ringed seals may abandon their pups when sea ice breaks up early.

Such steps include firm commitments to reduce emissions of greenhouse gases, such as carbon dioxide and methane, on both a national and international scale. They also include adapting human activities in response to a changing climate in ways that minimize adverse effects on wildlife and natural ecosystems. S&E

FLAME RETARDANTS: A THREAT TO THE ENVIRONMENT?

Flame retardants have been used since ancient times to protect people from the dangers of fire. Today, they are found in many products we use every day, including textiles, plastics, paints, televisions and computers. But there is growing evidence that these chemicals may be protecting us in one way and harming us in others.

Advances in chemistry have come a long way since the Egyptians and Romans first used alum to reduce the flammability of wood. There are now more than 175 different flame-retarding chemicals, which fall into four major groups: inorganic, halogenated organic, organophosphorous and nitrogen-based. Brominated flame retardants (BFRs)—the most common organic retardant—may be chemically bonded into plastics (reactive) or mixed with polymers and resins (additive).

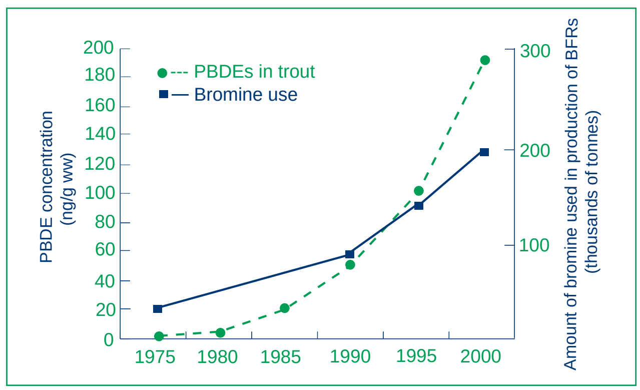
Additive retardants are believed to be more easily released into the environment than reactive ones. In 1979, the additive polybrominated diphenyl ether (PBDE) was detected in soil and sludge samples around a PBDE-manufacturing facility in the United States. Since then, studies in Europe, North America and Japan have pointed to the widespread distribution of these contaminants in fish, shellfish, fish-eating birds, marine mammals, and sediments. In the late 1990s, international concern increased when an analysis of breast-milk samples in Sweden showed that levels of PBDEs have increased exponentially since the early 1970s.

BDE molecules are similar in structure to polychlorinated biphenyls (PCBs), industrial chemicals that are classified as probable carcinogens and are known to cause birth defects, neurological damage and thyroid imbalances. Initial studies also indicate that BDEs—whose chemical structure resembles thyroxin—could interfere with the metabolism of thyroid hormones and their transport throughout the body.

Environment Canada's National Water Research Institute is leading national and international efforts to understand the sources, environmental behaviour and toxicity of brominated flame retardants, and help determine the risks they pose to human health. The Institute has organized and hosted three international workshops at which researchers from governments and universities have pooled their knowledge on the issue, including the problem of accurately measuring trace levels of PBDEs in different sectors of the environment.

Environment Canada and partners from Fisheries and Oceans Canada, Health Canada and the universities of Guelph and Trent have completed a multi-year investigation of the impact of PBDEs in Canada. Their study, which examined the levels of these chemicals in breast-milk, wildlife, biota, bird eggs, sediment and air in different parts of the country, confirms that they are a ubiquitous pollutant in Canada.

PBDEs were found in air samples from the Great Lakes and the Arctic, surface sediment from Lake Ontario, suspended sediment from Wapiti River in Alberta, and sludge from sewage-treatment plants in Ontario. They were detected in lake trout from the Great Lakes, fish and marine mammals from the St. Lawrence estuary, biota from the Canadian west coast, seals from Holman Island in the Northwest Territories, and Herring Gull eggs from the Great Lakes basin. Results from archived samples provide evidence that levels are on the rise in North America, unlike Europe and Japan, where they are on the decline.



Mean concentrations of total polybrominated diphenyl ether detected in Lake Ontario trout and the amount of bromine used globally for the production of brominated flame retardants between 1975 and 2000.

Environment Canada recently co-edited a special issue of the international journal *Chemosphere* presenting the current state of science on polybrominated diphenyl ethers and discussing challenges still to be met in determining their impact on the environment and human health. An emerging concern for both scientists and regulatory agencies is new evidence of high levels of PBDEs in human fatty tissue and blood serum, as well as in breast-milk.

Departmental researchers will continue to work with Canadian and international colleagues to clear up uncertainties about the release and long-range global transport of these pollutants, and to contribute to the assessment of their potential toxicity to humans. S&E

Researchers suspended on a swing stage collect ice samples for analysis from the face of a 3000-metre ice cliff on Snow Dome Mountain, in British Columbia.

GLACIERS PASS POLLUTANTS TO AQUATIC ECOSYSTEMS

Pesticides that have been banned or restricted in North America for decades are entering pristine aquatic ecosystems in western and northern Canada through glacial meltwater. Carried on the wind from countries as far away as China, these pollutants condense onto falling snow in cold, high-elevation environments, and are then locked in layers of snow and ice until the sun's warmth releases them.

Organochlorine pesticides such as DDT do not break down easily, so when they are ingested by organisms they accumulate in tissue and are passed on up the food chain. Subsequent to their entry into wide use in the 1940s and '50s, these chemicals have been linked with adverse health effects, including reproductive impairment in animals and cancer in humans. Restrictions on the use of these pollutants began in North America in the 1970s; however, they continue to be used in other parts of the world—particularly developing countries.

After noting surprisingly high concentrations of organochlorine pesticides in lake trout, glacier-fed lakes, and snow in pristine Rocky Mountain parks, Environment Canada scientists decided to investigate deposition trends at higher altitudes. To minimize cross-contamination from melting, they focused their work on Alberta's Snow Dome Mountain—the highest glacier in the Columbia Icefields.

To push the detection limit for organochlorines as low as possible, the research team opted not to take ice core samples, which are expensive and yield relatively little water for analysis. Instead, they lowered themselves into a 30-metre-deep crevasse on a window-washing swing stage and mined enough snow and ice to produce the equivalent of 20-40 litres of water per sample.

The thick annual layers in the crevasse went back only about 12 years, so the scientists had to obtain earlier samples from the face of a 3000-metre ice cliff, where the annual strata—although thinner—dated back to the 1940s. Equipped with mountain-climbing gear and with the assistance of a glaciologist, they were able to collect a full range of samples dating from 1959. These samples were later melted and analyzed in the lab.

Although environmental levels of DDT, dieldrin and chlordane have declined since the late 1970s in eastern North America, the results of this study showed these same chemicals reaching their peak concentrations on Snow Dome in the mid- to late-1980s. Lindane and endosulfan also exhibited peak concentrations in 1989, while hexachlorobenzene increased steadily, and may still be on the rise.

Since air masses at Snow Dome originate from continental Canada and the United States about 32 per cent of the time during the year and from the Pacific Ocean and Asia the remainder of the time, potential sources of the pesticides found in the Snow Dome glacier are Canada, the United States, Asia and Mexico. Asia, in particular, could be an important source of DDT deposited in the 1980s, as the production and use of this pesticide in China peaked in the 1970s.

Scientists and students at the University of Alberta followed up on this research by collecting snow and ice samples at other cold, high-altitude locations, and determined that the same trends hold true: pesticide concentrations increase in precipitation and ice with increasing elevations.

Results from these studies and others carried out on the extent of glaciers and ice fields on the Agassiz Ice Cap on northern Ellesmere Island, in Nunavut, suggest that glacial meltwater will release significant quantities of organochlorine pesticides into some alpine and northern marine coastal aquatic ecosystems for decades and perhaps centuries. These releases may contribute to the high level of pesticides known to occur in fish from glacier-fed lakes, and could pose a threat to the health of people and wildlife that feed on these fish. The impact of this phenomenon could be even more severe if temperatures continue to rise as a result of global warming.

Parts of the Snow Dome field study were recreated for use in a four-hour television series by Dr. David Suzuki that examines the interconnectedness of life. The series, which is based on Suzuki's book *The Sacred Balance,* is scheduled to air on CBC in the fall of 2002. S&E

DEFORESTATION THREATENS CANADA'S BOREAL PLAINS

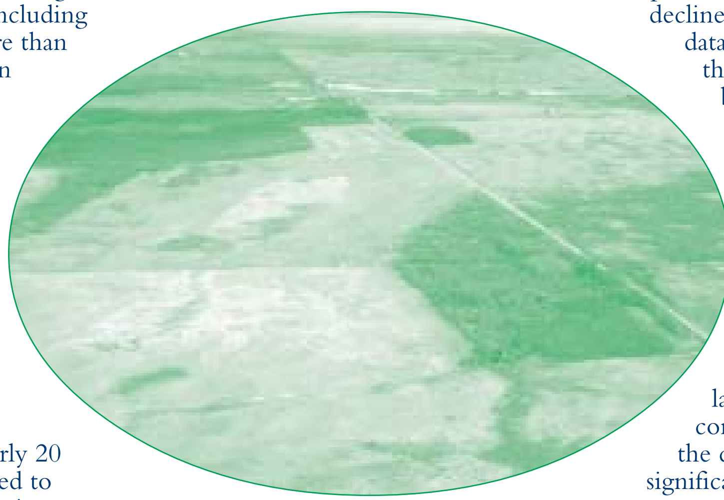
A diverse landscape of gently rolling lowlands and mixed boreal forest, Canada's Boreal Plains Ecozone is home to more species of breeding birds than virtually any other forest ecosystem in North America. In recent decades, however, human activities such as forestry and agriculture have contributed to habitat loss and the decline of some bird species populations in this important region.

The Boreal Plains Ecozone spans approximately 650 000 square kilometres of land in the Prairies, from southeastern Manitoba to northwestern Alberta. Most of this area contains boreal forest composed primarily of white spruce, black spruce, balsam fir, jack pine and tamarack on some peatlands, along with extensive hardwoods, including trembling aspen. Of the more than 200 bird species that breed in western Canada's southern boreal forest, about a third are long-distance migrants from tropical regions to the south—several of which are experiencing long-term declines. The remainder are short-distance migrants or residents.

Although the main industry in the Boreal Plains of Saskatchewan is forestry, nearly 20 per cent of the land is devoted to agricultural production of grains or cattle. Much of the southern portion of the Boreal Plains (known as the boreal transition ecoregion) was cleared for farming more than 60 years ago. In the more northern reaches of the boreal transition ecoregion, however, the direct conversion of forested lands to cereal or oilseed crops and pasture continues at a rapid rate.

To examine the issue more closely, wildlife researchers at Environment Canada documented forest loss in the boreal transition ecoregion of Saskatchewan (an area of nearly 50 000 square kilometres) and assessed whether certain factors influenced the distribution and rate-of-change in forest cover.

Based on satellite imagery and other data, they estimate that 73 per cent of the ecoregion has been converted to agriculture since European settlement. The area experienced an annual deforestation rate of 0.89 per cent between 1966 and 1994, compared to the world average of 0.3 per cent. Results also show that significantly less forest remains on lands that are privately owned, have soils with high suitability for agriculture, have high road density, or are in the southern portions of the study area.



An aerial view of part of the Boreal Plains Ecozone, showing the impact of agriculture on the face of the landscape.

To determine how changes in land use influenced relative abundance and diversity of bird species, the scientists examined North American Breeding Bird Survey data for five survey routes in Alberta, Saskatchewan and Manitoba that have been affected by loss and fragmentation of local forest habitat and drainage or degradation of wetlands. These routes were compared with a control route in similar but undisturbed habitat in the Boreal Shield Ecozone.

The Brightsand, Saskatchewan route, which once recorded the highest species richness of all Breeding Bird Survey routes in North America, saw diversity decline from a maximum of 105 species in 1987 to 67 species in 1995. In addition, 13 species that were regularly recorded before 1990 were experiencing major population declines. An analysis of land-cover data along the route indicated that forest cover had decreased by up to 55 per cent in just three decades.

Similar trends were reported on the other routes. Although all groups of birds—including forest, grassland and wetland species—declined, wetland-associated birds showed the largest drop in numbers. In contrast, none of the species on the control route showed significant population decreases.

The rate of deforestation of the boreal forest in western Canada may also have important implications for Canada's climate-change strategy. Forests play an important role in the global carbon cycle because they take up carbon dioxide—a greenhouse gas that traps heat from the sun inside the atmosphere. The conversion of forested lands to agriculture also further increases the emission of greenhouse gases, such as nitrous oxides from fertilizers and methane from manure and livestock.

Forests in the Boreal Plains Ecozone are vital to climate and biodiversity. This study will be important to the development and implementation of long-term land-use plans that preserve the ecological integrity of this threatened region. S&E

RARE BC ECOSYSTEMS UNDER SIEGE

Garry oaks on a coastal bluff in British Columbia. Photo: Mark Kaarremaa.

Time is running out for one of Canada's rarest and most biologically rich habitats. Over the past century and a half, some 99 per cent of British Columbia's Garry oak ecosystems have been cleared for logging, farming and urban development. Today, the last fragments are struggling to survive in the face of mounting pressure from developers, insect pests and invasive alien plants.

A mosaic of open rocky areas, grasslands, woodlands and meadows scattered with Douglas fir and lush wildflowers, Garry oak ecosystems range from southern BC to California. Restricted in Canada to the southeast coast of Vancouver Island, the southern Gulf Islands and a few isolated pockets in the Fraser Valley, they are listed by the provincial Ministry of Water, Land and Air Protection as endangered and at great risk of extirpation.

The rainshadow effect of Vancouver Island and the Olympic Mountains is responsible for the dry, Mediterranean-like climate of Garry oak ecosystems. As a result, many of the over 1000 different species of plants and animals found in these ecosystems are adapted to drought conditions—and a number are rare or endangered. Twenty-one species—such as the endangered Taylor's checkerspot butterfly and sharp-tailed snake—are listed as at risk nationally by the Committee on the Status of Endangered Wildlife in Canada. Another 93 are provincially at risk.

In addition to being threatened by the conversion of land for urban development and agriculture, Garry oak ecosystems have been affected by fire suppression and overgrazing by livestock, both of which have opened them to invasion by non-native plant species. In the past, fire likely played an important role in halting such invasion by scorching grass and shrubs and allowing trees to survive.

One particularly harmful introduced species, Scotch broom, has replaced native plants and changed soil nutrients, severely altering the make-up of these ecosystems. Garry oaks themselves are also under siege by insect pests such as gall wasps and phylloxeran aphids—both of which cause leaf scorching and premature defoliation, and weaken the trees by forcing them to expend energy trying to refoliate.

In an effort to prevent Canada's Garry Oak ecosystems from disappearing, a large number of government and environmental non-government organizations are working together to protect the few remaining relatively undisturbed examples of these ecosystems and to apply recovery strategies to other examples and their species at risk. In addition to being part of the recovery team, Environment Canada contributes funding to land acquisition and stewardship efforts through the Georgia Basin Ecosystem Initiative (GBEI)—a partnership that also includes Fisheries and Oceans Canada, and the BC ministries of Water, Land and Air Protection and Community, Aboriginal and Women's Services. The Habitat Stewardship Program administered through Environment Canada is also a source of on-the-ground funding for recovery and restoration efforts in these ecosystems.

The most recent purchases to receive GBEI funding were coastal bluffs on Galiano Island, which will be managed as a conservation area and bird sanctuary, land in Mill Hill Regional Park west of Victoria, and Canada's largest intact Garry-oak-dominated woodland on Saltspring Island. These parcels are key to the goal of establishing a network that is representative of Garry oak ecosystems across their geographic range, that supports native wildlife and plant life, and that is sustainable over the long term.

The importance of preserving this threatened habitat is underlined by emerging evidence that Garry oak ecosystems were at their most extensive during a warm, dry period after the last Ice Age. Their adaptation to summer drought could make these the ecosystems of the future, since such conditions may once again prevail as a result of global warming. 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.