Wild Species 2010

THE GENERAL STATUS OF SPECIES IN CANADA

Canadian Endangered Species Conservation Council
National General Status Working Group

This report is a product from the collaboration of all provincial and territorial governments in Canada, and of the federal government.

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Abstract

Wild Species 2010 is the third report of the series after 2000 and 2005. The aim of *the Wild Species* series is to provide an overview on which species occur in Canada, in which provinces, territories or ocean regions they occur, and what is their status. Each species assessed in this report received a rank among the following categories: Extinct (0.2), Extirpated (0.1), At Risk (1), May Be At Risk (2), Sensitive (3), Secure (4), Undetermined (5), Not Assessed (6), Exotic (7) or Accidental (8). In the 2010 report, 11 950 species were assessed. Many taxonomic groups that were first assessed in the previous *Wild Species* reports were reassessed, such as vascular plants, freshwater mussels, odonates, butterflies, crayfishes, amphibians, reptiles, birds and mammals. Other taxonomic groups are assessed for the first time in the *Wild Species* 2010 report, namely lichens, mosses, spiders, predaceous diving beetles, ground beetles (including the reassessment of tiger beetles), lady beetles, bumblebees, black flies, horse flies, mosquitoes, and some selected macromoths.

The overall results of this report show that the majority of Canada's wild species are ranked Secure. In fact, when excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, a total of 77% have a Canada General Status Rank (Canada rank) of Secure. This number varies considerably among taxonomic groups. The species groups that have the lowest proportion of species ranked as Secure were the reptiles (33%) and freshwater mussels (39%). At the opposite, ground beetles (88%), bumblebees (94%), mosquitoes (95%) and predaceous diving beetles (98%) were the taxonomic groups that had the highest proportion of species ranked as Secure. However, the high percentages of species ranked as Secure in these taxonomic groups might reflect our lack of knowledge on these species, since they were also among the taxonomic groups with the highest proportion of species ranked as Undetermined or Not Assessed.

One of the important achievements of this report is to update the status assessments of taxonomic groups that were included in previous *Wild Species* reports. Among the taxonomic groups that were reassessed in this report, 626 species had a change in their Canada rank. In total, 15% of the changes involved species moving into a rank with an increased level of risk, 27% involved species moving into a rank with a reduced level of risk, and 16% involved species moving into or out of the Undetermined, Not Assessed, Exotic or Accidental ranks. Updates have also resulted in the addition of 162 new species to the national list (26% of the changes) and 101 species have been removed from the national list (16% of changes). Most of these changes were due to improved knowledge of the species, but taxonomic changes, biological changes, and changes due to new detailed assessments from the Committee on the Status of Endangered

Wildlife in Canada (COSEWIC) also accounted for an important part of the reasons of the changes.

The report *Wild Species* 2010 also serves as a first warning on possible conservation concerns for some species that have not been looked in details previously. The species that are ranked as May Be At Risk by the National General Status Working Group (NGSWG) are species that could be candidates for more detailed assessments. A total of 806 species were ranked as May Be At Risk. These species could be prioritized by COSEWIC for more detailed status assessments. The taxonomic groups that had the most species ranked as May Be At Risk were the vascular plants (444 species), followed by lichens (100 species), mosses (71 species) and spiders (62 species).

One of the issues highlighted in this report is the large number of non-native species in Canada. Of the 11 950 species assessed in this report, 1426 species are ranked Exotic at the national level, meaning that these species are not native to Canada, but were introduced by humans. Of the groups covered in this report, the vascular plants have the highest proportion of Exotic species (24%). Exotic species have been brought to Canada, both deliberately and accidentally, from around the world, and can have a number of damaging impacts on native species, including competing for space and resources, preying on native wildlife, breeding with native species and introducing novel diseases and parasites.

Finally, one purpose of this report also is to encourage more information to be collected on species currently ranked as Undetermined or Not Assessed. In this report, a total of 1618 species had these ranks because of a lack of knowledge. It is hoped that the *Wild Species* series will continue to raise the profile of existing data gaps and stimulate people either to contribute data for these species, or to collect new data to address these shortfalls. Without information on the status of these species, it is difficult to judge how the human uses affect the ecosystems and species. The taxonomic groups that had the highest number of species ranked as Undetermined or Not Assessed were the spiders (477 species), the ground beetles (260 species), the mosses (235 species) and the lichens (218 species).

This report represents a huge achievement by summarizing the general status assessments of a large number and variety of wild species occurring in Canada. However, with a total number of species in Canada estimated to be more than 70 000, there are still many species left to be assessed. In the future, the *Wild Species* series will continue to consolidate our knowledge of wild species by using information from experts to create a baseline for comparison of the status of Canada's species.

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Section 1 – Introduction

Context

The year 2010 is the International Year of Biodiversity. This represents a unique opportunity to better understand the diversity of species that surround us, and to protect this diversity to our best. The report *Wild Species* 2010 perfectly fits within this context, by analyzing the situation for an impressive number of species present in Canada.

Canada is home to over 70 000 wild species including, but by no means limited to, mammals, birds, fishes, vascular plants, butterflies, dragonflies, bees, worms, mosses and mushrooms. These species, and other aspects of nature, are highly valued by Canadians. Canadians recognize that wild species provide a host of resources, such as foods, medicines and materials, as well as services that we often take for granted, such as cleaning the air and water, regulating the climate, generating and conserving soils, pollinating crops, and controlling pests. In addition, Canadians take pride in, and profit internationally from, a reputation for pristine landscapes with abundant wildlife. But perhaps above all else, Canadians value the aesthetic splendour and spiritual nourishment still afforded by the incredible range of wild species living in Canada. For all these reasons, we acknowledge a responsibility to future Canadians and the rest of the world to conserve our nation's natural heritage, by preventing the loss of species due to human actions.

The first step in preventing the loss of species is to know which species we have, where they occur and how they are doing. The aim of the *Wild Species* series is to provide this overview. The report *Wild Species 2010: The General Status of Species in Canada* presents the results of general status assessments for 11 950 species, including most of Canada's vertebrate species, all of Canada's vascular plants, macrolichens, mosses and several invertebrate groups. General status assessments integrate the best available information to create a snapshot of each species' status; their population size and distribution, the threats that each species faces in Canada, and any trends in these factors. General status assessments are used to categorize species into coarse-scaled general status ranks; some species will be ranked secure; some will show early signs of trouble and may need additional monitoring or management, while still others will be prioritized for detailed status assessments. General status ranks also highlight information gaps: for some species, there will not be enough information to assess whether they are secure or already in trouble. Each species receives a general status rank for each province, territory or ocean region in which it occurs, as well as a Canada General Status rank (Canada rank), reflecting the overall status of the species in Canada.

One of the strengths of this approach is that general status ranks are generated for many species in all regions of the country, allowing patterns of declines or threats to emerge across suites of species. In addition, general status ranks are reviewed and updated periodically. This will allow Canadians to begin to track patterns of improvement or decline through time, revealing which species are maintaining or improving their status and which are declining or facing new threats. Such patterns not only give a better indication of the nature and magnitude of a problem, but may also point the way to improved conservation practices.

The 2010 report is the third of the *Wild Species* series. A report is produced every five years and this one follows the 2005 and 2000 reports. The *Wild Species* series establishes a comprehensive, common platform for examining the general status of species across their Canadian range, as well as a solid baseline against which future changes in the distribution and abundance of species can be compared.

Assessing this mix of species from all regions of the country presents a considerable challenge - the number of species is large and the area great. The species are distributed across the length and breadth of Canada: 10 million square kilometres of land and fresh water, almost 6 million square kilometres of ocean, and 202 080 kilometres of coast (the longest coastline in the world). Across this massive area, the distribution of species is influenced by the staggering array of topography, soil types and habitats found within our borders including boreal forest, tundra, taiga, bogs, temperate rainforests, grasslands, marshlands, alpine meadows, the Atlantic, Pacific and Arctic Ocean coastlines.

Assessing the general status of Canadian species is challenging, but the process is essential. Our resource-based economy and high standard of living have an impact on the natural world: vegetation is cleared, cities expand, resources are extracted, waste is produced and exotic species are introduced. In altering nature for the benefit of Canadians, our goal must be to ensure that our activities do not imperil the very species that we both celebrate and depend upon. The *Wild Species* series is a tool for all Canadians; a guide indicating where more information is needed, a method of tracking changes in the status of Canada’s species over time, an effective tool for improved conservation, and a testimony to the cooperative will of Canadians to protect wild species.

The species concept

The general status assessment process assigns ranks to species, commonly defined as populations of organisms that do not usually interbreed with other populations, even where they overlap in space and time. Species are the most common and recognizable units of biological classification used in conservation, but they are not the only one. Subspecies (genetically distinct populations that may look and behave differently) and stocks (population divisions of harvested species, that may require different management approaches because they experience different ecological pressures) are examples of divisions below the species level. While these divisions have merit, there tends to be more disagreement over the precise limits and biological significance of differences observed at this finer scale. Moreover, relatively few species have been examined closely enough to distinguish whether or not subspecies or discrete stocks exist. Accordingly, only species were assigned general status ranks.

Life is variable at every conceivable scale. From the DNA that makes up an organism's genes to the composition and behaviour of entire ecosystems, a seemingly endless and complex array of living things surrounds us. The most familiar measure of diversity is the number and type of species, and this report focuses on that perspective of biodiversity (figure 1). However, the species perspective is not the only valuable viewpoint. For example, Canada's Arctic has relatively few species, but many of the species occurring there have special adaptations to extremes of climate that allow them to persist there and nowhere else. Variety in types of organisms is at least as important as their numbers, because different types of organisms have important, often irreplaceable, functions in nature. For example, certain species of fungi live in association with plant roots and provide the plant with vital minerals. Without their inconspicuous fungal partners, many species of vascular plants could simply not grow!

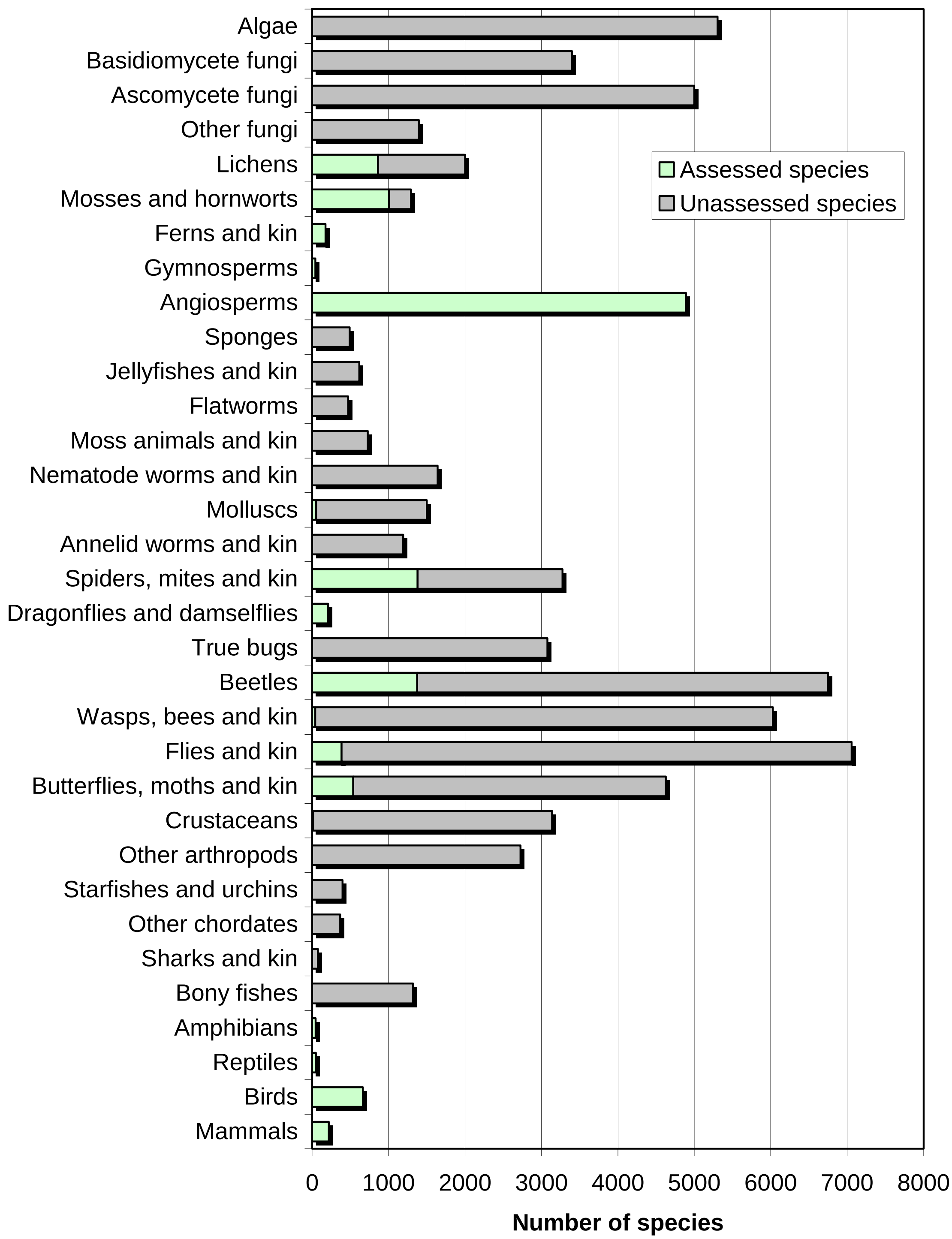

Figure 1. Diversity of species in Canada (about 70 000 species) and number of species assessed (11 950 species) in the report *Wild Species* 2010.

Why a report on species in Canada?

The *Wild Species* series on the general status of species in Canada is a requirement of the *Accord for the Protection of Species at Risk*, an agreement in principle established in 1996 by provincial, territorial, and federal ministers responsible for wildlife. The goal of the Accord is to prevent species in Canada from becoming extinct or extirpated because of human impact. As part of this goal, parties to the Accord agree to “monitor, assess and report regularly on the status of all wild species” with the objective of identifying those species whose populations are starting to decline, those for which a formal status assessment or additional management attention is necessary, and those for which more information is needed. Each province, territory, and federal agency responsible for wildlife undertakes to assess the species occurring within its jurisdiction.

Reports from the *Wild Species* series also serve as the basis to fulfill a requirement under the *Species at Risk Act* (SARA) of Canada. This Act is a key federal government commitment to prevent wildlife species from becoming extinct and secure the necessary actions for their recovery. Section 128 of this law stipulates that “five years after this section comes into force and at the end of each subsequent period of five years, the Minister must prepare a general report on the status of wildlife species” (Government of Canada, 2002). The first of the general report was tabled in Parliament in 2008 and reports from the *Wild Species* series will thereafter continue to serve as the basis to fulfill this requirement (Environment Canada, 2009).

What this report does

This report summarizes the general status assessments of a large number and variety of wild species occurring in Canada. It focuses on the general status of all species within each of these groups, rather than on the general status of only rare or endangered species. So, for example, one can ask questions like: Are salamanders doing better than frogs in Nova Scotia? Has the general status of salamanders in Nova Scotia changed since 2000? Is this pattern the same in Manitoba, or Canada as a whole? How does the general status of salamanders and frogs compare with that of other groups that are associated with water, like fishes? These and many other questions can be answered because the report draws together information on different types of species, from all provinces and territories and portions of three bordering oceans, and presents general status ranks for species in each region as well as overall Canada General Status Ranks (Canada ranks).

General status assessments focus on establishing what information and expertise already exist and using these to develop general status ranks for as many species as possible. This allows existing knowledge to be presented to the public rather than delaying a report until complete scientific information is available. There is a large number of species that are undescribed or unrecorded (i.e. species that are new to science or species that are already known to science but that have not yet been documented as occurring in Canada; Mosquin and Whiting, 1992).

The exceptional number and variety of species covered in the *Wild Species* series requires that it distill detailed information into broad general status categories. Accordingly, while in some cases the report draws upon the information available from initiatives devoted to particular species groups, regions, or functions, it is not a replacement for these efforts, which have a narrower focus and more specific aims. In particular, general status assessments do not replace comprehensive scientific evaluations by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or provincial and territorial equivalents, which provide in-depth, targeted assessments of individual species that may be at risk. General status assessments also differ in methods and scope from bird conservation plans (e.g. Partners in Flight for landbirds; Canadian Shorebird Conservation Plan for shorebirds; and Wings Over Water for seabirds and colonial waterbirds), which have developed their own priority-setting systems tailored to their unique program objectives.

The following is a summary of some of the achievements of the *Wild Species* series. This series:

• **integrates** information on a large number and variety of Canada's wild species (11 950 species in 20 groups), including most vertebrates and all vascular plants that have been found in Canada. This allows comparison of general status between individual species, as well as comparison within and between groups of species, based on taxonomic or regional boundaries;

• **alerts** Canadians to species that may require attention to prevent their extinction, before the species reach a "critical condition." Early warning of a species in trouble increases the success and cost-effectiveness of conservation programs. General status assessments also help to prioritize which species are in most urgent need of a more detailed status assessment, additional management attention, or basic research into population size, distribution, threats or trends;

• **updates** the general status of the species that were assessed for the first time in the previous reports. This comparison highlights species whose general status is declining or improving, shows where information gaps have been filled, and where further information is still required;

• **summarizes** the identity and distribution of select non-native wild species (exotic species) across Canada. Few Canadians are aware of fauna and flora that are introduced, or the potential impacts of exotics on native species;

• **identifies** gaps in our knowledge about wild species in Canada. Directing resources and expertise towards filling these gaps is essential for a more accurate and comprehensive picture of the general status of Canadian wild species;

• **establishes or enhances** local networks of people with information to share about Canada's wild species. People identified during this process form part of a coordinated knowledge base critical to this, and future, *Wild Species* reports;

• **shares** information with Canadians about the diversity and general status of wild species across the country. Consolidating information about wild species in Canada lets everyone from schoolchildren to resource managers, farmers, and developers know what species are present in Canada and how they are doing.

Users of the reports from the Wild Species series

Users of the reports from the *Wild Species* series include:

• **Committee on the Status of Endangered Wildlife in Canada (COSEWIC)** – General status ranks are used by some of the Species Specialist Subcommittees (SSCs) to help prioritize species for detailed COSEWIC status assessments.

• **Wildlife managers, land-use planning committees and co-management boards** – General status ranks used to provide lists of species in a given area, and a guide to species' status.

• **Industry and consultants** – General status ranks provide information used to conduct environmental impact assessments.

• **Funding programs** – General status ranks used to help prioritize which research and conservation projects are funded.

• **Research scientists** – General status ranks used to obtain lists of exotic species, and distributions of species in Canada.

• **General public** – General status ranks used to provide lists of species in a given area, as a guide to species' status, and to provide information used to check the accuracy of environmental impact assessments.

• **Educators and students** – General status ranks and the reports from the *Wild Species* series have been used as an educational resource and a research tool.

Summary of Wild Species 2000

The *Wild Species* 2000 report (Canadian Endangered Species Conservation Council, 2001) was the first report on the general status of species in Canada, and summarized the provincial/territorial/oceanic region and Canada General Status Ranks (Canada ranks) of species in eight groups: ferns, orchids, butterflies, freshwater fishes, amphibians, reptiles, birds and mammals. Birds comprised the largest species group studied. The original 2000 database was updated in 2002 with the addition, among other things, of the completed Canada ranks for freshwater fishes and butterflies. A total of 1670 species were then assessed (figure 2). The majority (74%) of species had Canada ranks of Secure, while 5% had Canada ranks of At Risk and 5% had Canada ranks of May Be At Risk (table 1). Reptiles represented the taxonomic group with the lowest percentage of species ranked as Secure. The report also underlined that exotic species represented a potential problem. As predators, parasites, and competitors of native species, exotic species have the potential to cause ecological disturbance in communities. Importantly, freshwater fishes made up the majority of exotic species recorded in that report.

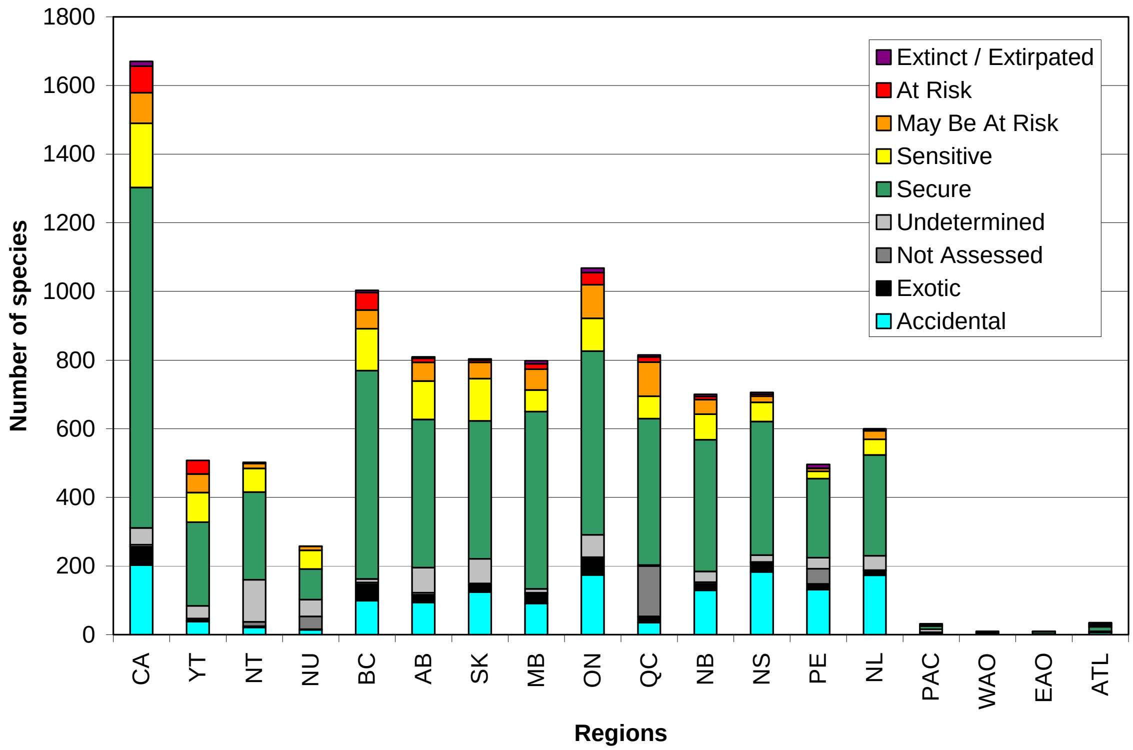

Figure 2. Results of the general status assessments for all species in the *Wild Species* 2000 report in Canada. The analyses include the database updated in 2002 for the freshwater fishes and for the butterflies.

Note: Codes used for the regions are described in the methods.

Table 1. Number of species (*n* = 1670) assessed in the *Wild Species* 2000 report according to the different taxonomic groups. The analyses include the database updated in 2002 for the freshwater fishes and for the butterflies.

Taxonomic group	Number of species	Proportion of Secure*
Ferns	122	66%
Orchids	78	68%
Butterflies	293	78%
Freshwater fishes	232	68%
Amphibians	45	64%
Reptiles	46	43%
Birds	639	80%
Mammals	215	75%
TOTAL	1670	74%

* When excluding species ranked as Extinct / Extirpated, Undetermined, Not Assessed, Exotic or Accidental.

Summary of Wild Species 2005

The *Wild Species* 2005 report (Canadian Endangered Species Conservation Council, 2006) was the second report on the general status of species in Canada. A total of 7732 species were assessed from all provinces, territories, and ocean regions (figure 3), representing all of Canada's vertebrates species (fishes, amphibians, reptiles, birds and mammals), all of Canada's vascular plants, and four invertebrate groups (freshwater mussels, crayfishes, odonates and tiger beetles). Of the species ranked At Risk, May Be At Risk, Sensitive and Secure, a total of 70% had a Canada General Status Rank (Canada rank) of Secure (table 2). Again, one of the issues highlighted in this report was also the large number of non-native species in Canada. Of the 7732 species assessed in *Wild Species* 2005, 16% were ranked Exotic at the national level, meaning that these species are not native to Canada, but were introduced by humans. Of the groups covered in this report, the vascular plants (including ferns and orchids) had the highest proportion of Exotic species (24%).

In total, 1330 species that were assessed in the *Wild Species* 2000 report were reassessed in the *Wild Species* 2005 report. Of these, 12% have been assessed with a different Canada rank in 2005. However, changes in Canada ranks primarily reflect attempts to provide a more accurate picture of species' status, and not true biological change (i.e. changes in species population size, distribution or threats) since 2000. In total, 39% of changes involved species moving into a rank with an increased level of risk, 31% of changes involved species moving into a rank with a reduced level of risk, and 30% involved species moving into or out of the Undetermined, Not Assessed, Accidental or Extirpated categories. Considering only the species ranked in both 2000 and 2005, changes in Canada rank have not had a significant impact on the proportion of species in each general status category.

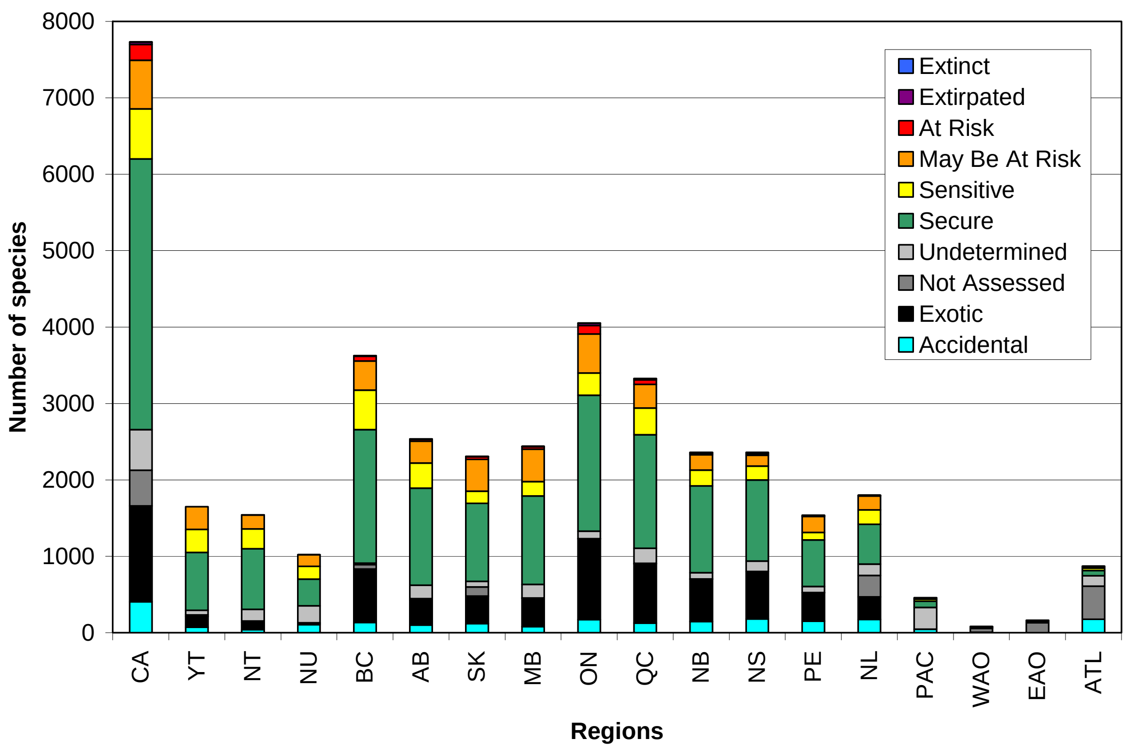

Figure 3. Results of the general status assessments for all species in the *Wild Species* 2005 report in Canada.

Note: Codes used for the regions are described in the methods.

Table 2. Number of species (*n* = 7732) assessed in the *Wild Species* 2005 report according to the different taxonomic groups.

Taxonomic group	Number of species	Proportion of Secure*
Vascular plants (including ferns and orchids)	5074	70%
Freshwater mussels	55	37%
Crayfishes	11	78%
Odonates	209	73%
Tiger beetles	30	72%
Fishes	1389	69%
Amphibians	46	65%
Reptiles	47	31%
Birds	653	82%
Mammals	218	74%
TOTAL	7732	70%

* When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental.

Further information

Accord for the Protection of Species at Risk. http://www.sararegistry.gc.ca/approach/strategy/default_e.cfm#2 (Accessed February 23, 2010).

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Government of Canada. 2002. Species at Risk Act. Department of Justice Canada, Ottawa: 91 pp.

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Section 2 – Data sources and methods

Working group

This report is the responsibility of the National General Status Working Group (NGSWG), under the direction of the Canadian Wildlife Directors Committee (CWDC), and ultimately under the direction of the Canadian Endangered Species Conservation Council (CESCC). The NGSWG is composed of representatives from all provincial and territorial governments in Canada, and three federal agencies: Environment Canada (Canadian Wildlife Service – CWS), Parks Canada, and Fisheries and Oceans Canada (DFO). In 2009, three ex officio members also joined the working group: Agriculture and Agri-Food Canada, Natural Resources Canada, and NatureServe Canada. To produce the reports of the *Wild Species* series, the NGSWG established the guidelines for the criteria that would be used to derive general status ranks. The NGSWG also established which taxonomic groups of species were ranked in each report. A list of NGSWG members appears at the end of this report (appendix 1).

General status ranks were created at two scales; regional and national (figure 4). At the regional scale, ranks were created for each province and territory. Since marine species (e.g. whales) are often difficult to associate with a particular province or territory, ranks were also generated in four ocean regions; Pacific Ocean Region, Western Arctic Ocean Region, Eastern Arctic Ocean Region and Atlantic Ocean Region. Provincial and territorial representatives hold the primary responsibility for establishing lists of species that occur in their region, as well as for sourcing, compiling, storing and interpreting the information that informs their region's ranks for a given species. DFO holds the primary responsibility for establishing lists of species that occur in each oceanic region and compiling ranks for each marine species.

Once regional (i.e. provincial, territorial, and oceanic) general status ranks are completed, the NGSWG is responsible for assigning a Canada General Status Rank (Canada rank); a national rank that interprets the overall state of the species in Canada based on the information provided by each province, territory, or ocean region where the species occurs.

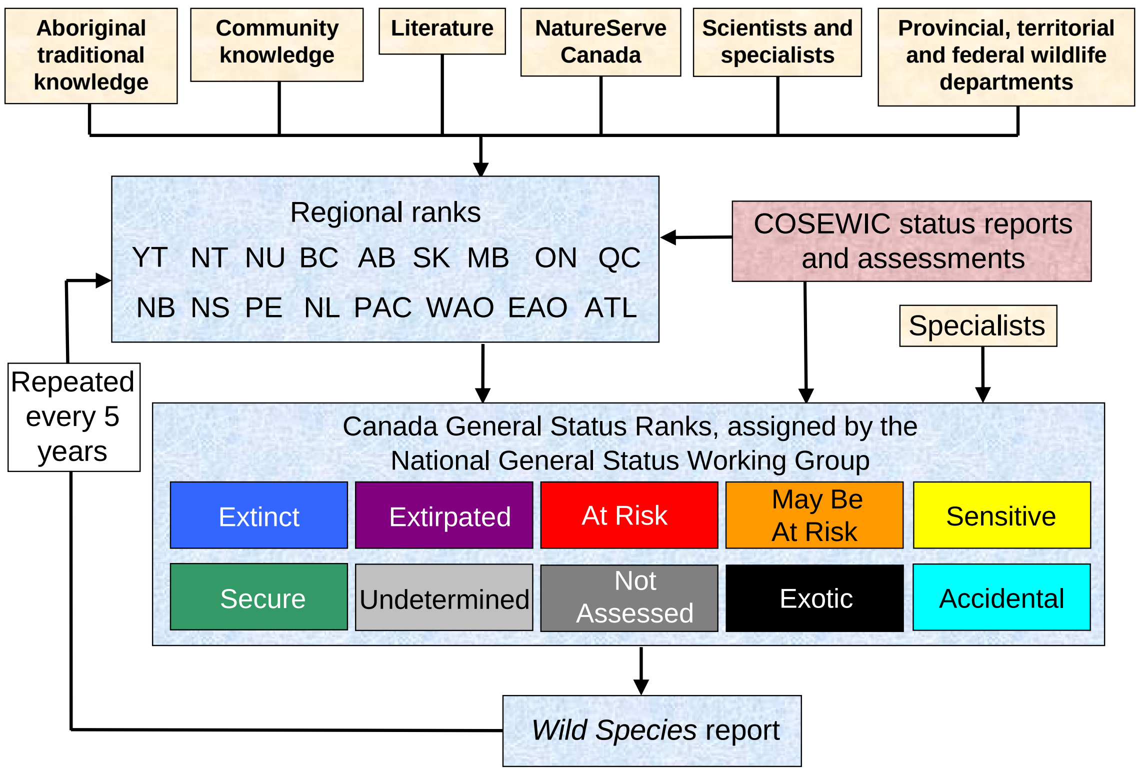

Figure 4. Diagram outlining how regional ranks (i.e. provincial, territorial and ocean region ranks) and Canada ranks are generated.

Codes used for the regions

The National General Status Working Group uses codes to represent the studied regions. Table 3 lists the codes used to represent the regions in this report. Figure 5 shows the location of these regions.

Table 3. Codes used to represent the regions in the report *Wild Species 2010*.

Code	Regions
CA	Canada
YT	Yukon
NT	Northwest Territories
NU	Nunavut
BC	British Columbia
AB	Alberta
SK	Saskatchewan
MB	Manitoba
ON	Ontario
QC	Quebec
NB	New Brunswick
NS	Nova Scotia
PE	Prince Edward Island
NL	Newfoundland and Labrador
PAC	Pacific Ocean
WAO	Western Arctic Ocean
EAO	Eastern Arctic Ocean
ATL	Atlantic Ocean

Figure 5. Map of Canada, showing the 13 provinces and territories and the four oceans regions for which general status ranks are generated.

Sources of information

Achieving the most accurate overall impression of a species' status requires compiling local information to generate regional and then a national picture of a species' general status. This makes assessing the general status of Canada's species a complicated and challenging task because there are many species and most are distributed across a vast area. Fortunately, there are many sources of information about Canada's species, some in published documents, but much in the accumulated knowledge and expertise of people. For example, amateur naturalists, museum specialists, government biologists, and holders of community knowledge or aboriginal traditional knowledge are often key to determining which species occur within a region and assessing their status. The provincial, territorial and federal wildlife departments in Canada collect and maintain this information.

In many provinces, some of this local knowledge is already maintained within the network of Conservation Data Centres (CDCs) and Natural Heritage Information Centres (NHICs) of NatureServe Canada. The member programs of NatureServe Canada have the responsibility to house biodiversity information for their respective jurisdiction, as well as actively collect and verify data on species and ecological communities. Through standardized methodology and data management systems, data is examined by experts, maintained and made available for analyses. Currently, the NatureServe Canada network consists of eight member programs in all provinces (the Atlantic Canada provinces are represented by one regional member program) and in one territory (Yukon). The network of NatureServe Canada belongs to the international network of NatureServe. The General Status process draws upon expertise and data held within NatureServe Canada's network of Conservation Data Centres and Natural Heritage Information Centres for status information of many taxonomic groups.

Involving a great variety of people with knowledge to share about species ensures that the best and most comprehensive picture of a species' general status is achieved. An added benefit is that the extensive consultation required to collect data for species' general status assessments fosters a connection of expertise that is an enduring resource for wildlife management and conservation within each province or territory. This accumulated knowledge results in lists of species in a given region and, in most cases, sufficient information for the province or territory to establish a general status rank for each species. In addition, information gaps identified during the assessment process indicate where investment may be necessary to develop expertise in particular species groups, where additional surveys and research needs to take place, and highlight the need to capture the knowledge currently held by today's experts in a lasting form.

Criteria underlying general status assessments

The general status of a given species was reached by considering available information relating to a set of seven criteria that collectively reflect the status of a species' population within specific geographic areas – that is, provinces, territories, ocean regions, and Canada as a whole (National General Status Working Group, 2003). These criteria were based on definitions developed and applied by the International Union for the Conservation of Nature (IUCN, 2001), the Criteria for Amendment of Appendices I and II (Res. Conf. 9.24) of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the conservation status assessment criteria developed by NatureServe. Criteria were used as a guide to help determine the appropriate general status category for a species. Where possible, representatives from each province, territory, and federal agency followed the following definitions of the seven criteria:

• **Population size** – Defined as the current estimate of the total number of mature individuals capable of reproduction. Where populations are characterized by natural fluctuations, the minimum number should be used. Likewise, if the population is characterized by biased breeding sex ratios, it is appropriate to use lower estimates for the number of mature individuals that will take this into account. For many species, a figure of less than 1000 individuals has been found to be an appropriate guideline of what constitutes a small population. It is likely that different definitions of what constitutes a "small" population will need to be developed for different taxonomic groups.

• **Number of occurrences** – Defined as the estimated number of sites where the species currently occurs. A site occurrence is described ecologically as a location representing a habitat that sustains or otherwise contributes to the survival of a population. A site occurrence will be defined differently for different species, depending on its natural history. When a species' distribution is extremely limited and there are very few site occurrences, the species is very susceptible to any number of disturbances, both predictable and unpredictable. Therefore, when the number of occurrences is few, this criterion is usually the single most important factor influencing overall rank.

• **Geographic distribution** – Defined as the area contained within the shortest continuous imaginary boundary that can be drawn to encompass all known, inferred, or projected sites of occurrence, excluding outlier occurrences (i.e. chance occurrences, unlikely to be repeated). The area within the imaginary boundary should, however, exclude significant areas where the species does not occur. For migratory species, the geographic distribution is the smallest area essential at any stage for the survival of the species.

• **Trend in population** – Defined as an estimate of the change (if any) in the number of mature individuals over time. Where declines are indicated, rapidly declining is defined as a decrease of 50% in the last 10 years or three generations, whichever is longer. Declining is defined as a decrease of 20% in the last 10 years or three generations, whichever is longer. Natural fluctuations will not normally count as part of a decline, but an observed decline should not be considered part of a natural fluctuation unless there is evidence for this interpretation.

• **Trend in distribution** – Defined as the change (if any) in the geographic distribution of the species over time. Where declines in distribution are indicated, rapidly declining is defined as a decrease of 50% in the last 20 years or six generations, whichever is longer. Declining is defined as a decrease of 20% in the last 20 years or six generations, whichever is longer.

• **Threats to population** – Defined as observed, inferred, or projected direct exploitation, harassment, or ecological interactions with predators, competitors, pathogens, or parasites that may result in population declines. Extreme threats are significant, could affect more than half the population, and are unmitigated. Moderate threats are also serious but affect less than half the population or are mitigated by some level of human protection. Limited threats are less significant to population viability or are being mitigated through protective measures.

• **Threats to habitat** – Defined as observed, inferred, or projected habitat alterations (loss, conversion, degradation, or fragmentation) that may result in population declines. Extreme threats are significant, affect more than half the population, and are unmitigated. Moderate threats are also serious but affect less than half the population or are mitigated by some level of human protection. Limited threats are less significant to population viability or are being mitigated through protective measures.

The scores given to the criteria can guide the general status rank for a given species in a province, territory, or ocean region. Each score is a relative assessment based on available data, since for most species, definitive, qualitative data are rare. Therefore, thresholds between scores are not absolute. The amount and type of information (e.g. empirically versus anecdotally based) were used as factors in weighting the contribution of each score to the final overall rank. Thus, each general status rank is not a simple average of component criteria scores but depends on the particular character of the information underlying each criterion.

General status categories

Each species assessed in the *Wild Species* reports received a rank (often represented by a numerical code) that summarizes its general status. Each general status assessment was based upon a series of criteria (see previous section) that capture information, where available, on population size and distribution, threats to individuals or their habitat and trends (increases or decreases) in these factors. Species received a general status rank in each province, territory, or ocean region in which they are known to be present, as well as an overall Canada General Status Rank (Canada rank).

General status categories are necessarily broad, both because the large number of species covered precludes the detailed and intensive species assessments that would inform a finer scaled system, and because of variation in the amount of information available for different species. The reader should also note that all general status categories refer only to a species' status in Canada. Where the species also occurs outside of Canada (as most of our species do), the situation for those populations of the species may be different. For example, a species that is abundant elsewhere (e.g. USA, Europe) may exist in Canada in very low numbers. In this case, it could be ranked as May Be At Risk, reflecting the Canadian general status and level of concern for its future here, while being of lesser conservation concern in other parts of its range. Table 4 presents the general status categories used in this report.

Table 4. General status categories used in the *Wild Species* 2010 report.

Rank	General status	Description
0.2	Extinct	Species that are extirpated worldwide (i.e., they no longer exist anywhere). This rank partially replaces the rank of Extirpated/Extinct, used in the *Wild Species* 2000 report.
0.1	Extirpated	Species that are no longer present in a given geographic area, but occur in other areas. This rank partially replaces the rank of Extirpated/Extinct, used in the *Wild Species* 2000 report.

1	At Risk	Species for which a formal, detailed risk assessment (COSEWIC status assessment or provincial or territorial equivalent) has been completed and that have been determined to be at risk of extirpation or extinction (i.e. Endangered or Threatened). A COSEWIC designation of Endangered or Threatened automatically results in a Canada General Status Rank (Canada rank) of At Risk. Where a provincial or territorial formal risk assessment finds a species to be Endangered or Threatened in that particular region, then, under the general status program, the species automatically receives a provincial or territorial general status rank of At Risk.
2	May Be At Risk	Species that may be at risk of extirpation or extinction and are therefore candidates for a detailed risk assessment by COSEWIC, or provincial or territorial equivalents.
3	Sensitive	Species that are not believed to be at risk of immediate extirpation or extinction but may require special attention or protection to prevent them from becoming at risk.
4	Secure	Species that are not believed to belong in the categories Extinct, Extirpated, At Risk, May Be At Risk, Sensitive, Accidental or Exotic. This category includes some species that show a trend of decline in numbers in Canada but remain relatively widespread or abundant.
5	Undetermined	Species for which insufficient data, information, or knowledge is available with which to reliably evaluate their general status.
6	Not Assessed	Species that are known or believed to be present regularly in the geographic area in Canada to which the rank applies, but have not yet been assessed by the general status program.
7	Exotic	Species that have been moved beyond their natural range as a result of human activity. In this report, Exotic species have been purposefully excluded from all other categories.

8	Accidental	Species occurring infrequently and unpredictably, outside their usual range.

In some cases, general status ranks were the result of a further weighting of all criteria for which information was available. Another common method for generating general status ranks, is for provinces and territories which have member programs in the NatureServe Canada network to convert their existing subnational conservation status ranks (S ranks), developed by their Conservation Data Centre or Natural Heritage Information Centre, into general status ranks. Botanists and zoologists within the NatureServe Canada network regularly conduct field work for monitoring species and gather data for updating species ranks, as well as participate directly in the general status process for species in their jurisdictions.

Updated general status assessments

In the different reports of the *Wild Species* series, some changes in the general status of species may have been observed. The first step for provinces and territories was to check for changes to the species list. These could include new species, taxonomic changes and correction of errors. Additional species were assessed using the criteria for new general status assessments, described above. The next step was to compare species that occurred in the different reports of the *Wild Species* series. For each species, if no major change in abundance, distribution, trends or threats was found to have occurred, or if no new information was available, the species usually retained the rank it was given in the previous report. If major changes were believed to have occurred, or if new information was available (e.g. a new COSEWIC status assessment, or a new survey showing a broader distribution), the species was reassessed using the same criteria as for a new general status assessment.

From regional to national general status assessments

A Canada General Status Rank (Canada rank) was assigned for each species in order to provide a coarse-scale picture of national general status. Canada ranks were assigned by the NGSWG through a review of ranks and associated information from provinces, territories, and ocean regions. In general, where ranks vary across the country, the regional rank that represents the lowest level of risk (excluding ranks of Undetermined, Not Assessed, Exotic or Accidental) was used as the Canada rank. For example, Smooth Greensnake (*Opheodrys vernalis*) is ranked Undetermined in Prince Edward Island; Sensitive in Saskatchewan, Manitoba and Quebec; and Secure in Ontario, New Brunswick and Nova Scotia. Therefore, Smooth Greensnake received a Canada rank of Secure. However, the geographic distribution of the species was also taken into account so that a region harbouring the majority of a species' range carried more influence in determining the Canada rank, than did a region in which the species was only marginally represented. For example the Barrenground Shrew (*Sorex ugyunak*) is ranked Sensitive in the Yukon and Undetermined in the Northwest Territories and Nunavut. If the usual guideline was followed, the Canada rank for this species would be Sensitive. However, since only a small portion of this shrew's range is in the Yukon, the Barrenground Shrew was given a Canada rank of Undetermined.

Finally, for species with restricted breeding range (especially shorebirds), status within the breeding range was particularly important in determining the Canada rank. For example, within Canada, the Ruddy Turnstone (*Arenaria interpres*) breeds primarily on the tundra in northern Nunavut. Here it is ranked Sensitive due to population declines. However, the Ruddy Turnstone is a common migrant in suitable habitat throughout much of southern Canada, and is ranked Secure in every province except Quebec, where it is ranked Sensitive. If the normal procedure of assigning the rank with the lowest level of risk as the Canada rank was followed, the Canada rank would be Secure. However, Ruddy Turnstone received a Canada rank of Sensitive, due to concerns within its breeding range. For more information on this type of exception, please see the taxonomic groups in the results section.

The general status search tool

National and regional general status ranks for each species assessed can be found by using the general status search tool. Information presented includes English and French common names, scientific name, taxonomic group, Canada rank, regional general status ranks, and year of assessment. In addition, a comments section is available which supplies relevant additional information, and links to COSEWIC and IUCN webpages where applicable. The general status search tool can be used to search the general status ranks by common name, scientific name, region, rank, taxonomic group or year. The search tool is available on the *Wild Species* website.

Further information

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Parks Canada. http://www.pc.gc.ca/ (Accessed February 23, 2010).

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National General Status Working Group. 2003. Guidelines for assessing the general status of wild species in Canada, version 2.0. Canadian Endangered Species Conservation Council (CESCC): 19 pp.

Section 3 – Results of the general status assessments

The general status ranks for the Yukon, Northwest Territories and Nunavut are draft ranks until they have been reviewed by the Yukon Fish and Wildlife Management Board, the Wildlife Management Advisory Council (North Slope), the Wildlife Management Advisory Council (Northwest Territories), the Sahtu Renewable Resources Board, the Gwich'in Renewable Resources Board, the Wek'èezhii Renewable Resources Board and the Nunavut Wildlife Management Board (NWMB).

Assessed taxonomic groups

This report presents the general status assessments for 20 groups of species (table 5). These groups are the lichens, mosses, vascular plants, freshwater mussels, spiders, odonates, predaceous diving beetles, ground beetles, lady beetles, bumblebees, black flies, horse flies, mosquitoes, some selected macromoths, butterflies, crayfishes, amphibians, reptiles, birds, and mammals. A total of 11 groups of species are being assessed for the first time by the National General Status Working Group, namely lichens, mosses, spiders, predaceous diving beetles, ground beetles (including tiger beetles reassessment), lady beetles, bumblebees, black flies, horse flies, mosquitoes, and some selected macromoths.

In addition, the *Wild Species* 2010 report also provides reassessments (updated species list and general status ranks) for nine taxonomic groups that were first assessed in the report *Wild Species* 2000 or *Wild Species* 2005. The taxonomic groups that were reassessed are the vascular plants, freshwater mussels, odonates, butterflies, crayfishes, amphibians, reptiles, birds and mammals. Some of these groups are assessed for the second time, while others are assessed for the third time (table 5).

Table 5. Summary of the taxonomic groups that were assessed in the reports (2000, 2005 and 2010) of the *Wild Species* series.

Taxonomic group	2000	2005	2010
Lichens			X (macrolichens only)
Mosses			X
Vascular plants	X (ferns and orchids only)	X (all species)	X (all species)
Molluscs			
- Freshwater mussels		X	X
Spiders			X
Insects			
- Odonates		X	X
- Predaceous diving beetles			X
- Ground beetles		X (tiger beetles only)	X (all species)
- Lady beetles			X
- Bumblebees			X
- Black flies			X
- Horse flies			X
- Mosquitoes			X
- Selected macromoths			X
- Butterflies	X		X
Crustaceans			
- Crayfishes		X	X
Fishes	X (freshwater)	X (marine and freshwater)	
Amphibians	X	X	X
Reptiles	X (marine and terrestrial)	X (marine and terrestrial)	X (marine and terrestrial)
Birds	X	X	X
Mammals	X (marine and terrestrial)	X (marine and terrestrial)	X (marine and terrestrial)

Interpretations of the results

In the following sections, an overview is provided for each taxonomic group assessed for the current report. Each overview gives some background information on important characteristics of that group of species, their role in the environment, status of knowledge of the group in Canada, and, most importantly, some key statistics gleaned from the general status ranks for that group. Overviews for groups that were reassessed also provide a comparison with ranks presented in the previous *Wild Species* reports, along with a brief discussion of the reasons for changes. General status ranks for individual species at the national level, or for a particular province, territory, or ocean region, can be found by consulting the database or the General Status Search Tool available on the *Wild Species* website.

The general status ranks present the best estimate of the general status of these species at the time of assessment. However, the situation for species is dynamic: some populations will fare better or worse in the time between this report and the next. The reader is cautioned against over-interpreting differences in general status ranks; they are best viewed as a coarse-scaled guide, based on the best information available at the time of assessment to allow comparison among species and regions. Variability in general status ranks is introduced when we try to compare the status of groups with widely different life histories and habitat requirements. For example, if you imagine trying to compare the number of occurrences, the distribution and the population size of a tiger beetle, a bear and a migratory marine fish, you will see why general status categories must necessarily be broad and somewhat flexible. In addition, while general status ranks are based on the best available information at the time of completion, the quality of information varies widely among species, and among regions, and definitive, quantitative data are simply not available for many species, nor likely to be available in the near future. Variation in general status ranks does not diminish their value as guides to a species' status, but it does necessitate a conservative approach to their interpretation.

In the *Wild Species* 2010 report, we present two calculations of the percentage of species that are ranked as Secure. Firstly, in the "Quick facts" section of the text of each taxonomic group, we present the percentage of species ranked as Secure among the resident native species (excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental). Secondly, in the tables showing the results of the assessments, we present the percentage of species included in all rank categories, including the rank Secure.

Macrolichens

Lichens - Lichens are fungi that have established a symbiotic relationship with an alga or cyanobacterium or both.

Quick facts

- There are about 2000 species of lichens in Canada, of which 861 can be considered as macrolichens. There are about 15 000 species of macrolichens worldwide.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (72%) of macrolichens in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 16% have Canada ranks of May Be At Risk and 11% have Canada ranks of Sensitive. Five macrolichen species (1%) have a Canada rank of At Risk following a detailed assessment by COSEWIC.

- One macrolichen species is recorded as Extirpated from Canada.

- Lichens can grow almost anywhere in the world in environments ranging from extreme heat to extreme cold.

- Moisture is essential for the growth of lichens. Lichens act like a sponge and absorb water over their entire surface. In the same way that they absorb water, they also dry out rapidly and become dormant.

Brown-eyed Wolf Lichen, *Letharia columbiana* © Doug Waylett

Background

Lichens are fungi that have established a symbiotic relationship with an alga or cyanobacterium or both. In this type of relationship, the fungus and alga live together and both generally benefit from the association. The fungus provides structural support to the alga by surrounding the algal cells with hyphae or strands of fungal tissue. It also provides a relatively stable microhabitat for the algal cells to exist. The algae in turn provide carbohydrates and sugars produced in photosynthesis (the green pigment, chlorophyll, contained in the algal cells utilizes sunlight to produce carbohydrates and sugars from carbon dioxide and water). The fungus and alga have evolved together in such a way that an equilibrium exists, whereby the fungus does not utilize all of the carbohydrates and sugars made by the alga, while the alga derives structural integrity from the fungus. Most lichens obtain their shape from the fungal component (often called the mycobiont) with the algal component (the photobiont) restricted to a narrow band of cells located near the upper surface of the lichen.

The process of a fungus and alga joining to form a lichen is called lichenization. When a lichen is separated in the laboratory into its fungal and algal components and these are cultured separately, they grow perfectly well. Each forms its characteristic fungal or algal form. When these same components are mixed together under the right conditions, the new association takes the form of the parent lichen. The fungus appears to contain all the genetic information it needs to create the characteristic form of the lichen, but requires the alga or cyanobacterium to ‘turn on’ the fungal genes that control this morphogenesis or change in time controlled by an external or internal event.

There are about 15 000 species of macrolichens in the world, but this number is continually growing as more species are described. The names given to these lichens apply to the fungal symbionts and hence all lichens belong to the Kingdom Fungi. In almost all lichens, the fungus is an ascomycete or cup fungus with spores formed in sacs or asci. In a small number of species, the fungus is a basidiomycete or mushroom where the spores are formed on club-shaped basidia.

The lichen body or thallus is made up of three main layers – cortex, algal layer and medulla. The cortex is specialized tissue composed of compact fungal cells that forms a protective covering for the lichen. The algal layer, composed of algal cells intertwined with strands of fungal hyphae, is usually located beneath the outer or upper cortex. The medulla or inner layer is composed only of fungal hyphae.

Lichens can grow almost anywhere in the world. Some lichens are able to colonize the very hot or cold harsh environments of deserts and others can survive in the cold, snowfree alpine habitats where most other plants are not able to exist. In these extreme environments, crustose lichens that are tightly attached to their wood or rock substrate, may only grow a fraction of a millimetre a year and reach several hundred years in age, whereas foliose lichens growing in temperate or tropical areas may grow one centimetre or more per year.

Moisture is essential for the growth of lichens. Lichens act like a sponge and absorb water over their entire surface. In the same way that they absorb water, they also dry out rapidly and become dormant. When in this dormant stage, the physiological process of photosynthesis stops while respiration is greatly slowed. Studies have shown that lichens that have been dormant for several years are capable of physiological function when again moistened.

Status of knowledge

Historically, early botanists in Canada were the first to collect and identify lichens. However, their main focus was to collect and name vascular plants. Today, we still have many of these early collections in herbaria throughout the country. Both amateurs and professionals use these herbaria to aid in identifying and naming lichen species. Modern methods in genetics and DNA sequencing are re-grouping lichen species along evolutionary lines into new genera and species. Lichenology has worldwide organizations, journals and web sites that keep lichenologists in touch with one another and up-to-date regarding research topics and results.

Lichens produce secondary chemical compounds that are useful in their identification. Spot tests, for example, using household bleach that turns the lichen medulla red, will identify lecanoric acid in speckled shield lichens (*Punctelia*). These chemical compounds also protect the lichen from herbivory by animals, insects and other fungi. Botanical and medicinal research uses lichens and their secondary substances for tests in cures for cancer and other medical conditions.

With the onset of the industrial revolution in Europe, it was observed that lichens were disappearing from these industrial areas that were later called “lichen deserts”. Nowadays lichens are widely recognized as sensitive indicators of air pollution, particularly sulphur dioxide. A reason for this sensitivity is that the biology of the lichen is unique in that it has no vascular system for conducting water or nutrients as seen in vascular plants. Thus, lichens have no means to retain water, such as a leaf cuticle or stomate. Consequently, lichen water status varies passively with the environment, although the lichen can absorb moisture and nutrients from fog, dew and highly humid air. From an air pollution perspective, there are several reasons why these attributes are important. The lichen is a long-lived perennial organism that is exposed to air pollutants all year. If injury to either the alga (photobiont) or fungus occurs from these pollutants, the symbiotic association of the lichen may disintegrate. The lack of stomata and cuticle in lichens results in aerosols being absorbed over the entire surface area. Sulphur dioxide (SO_2) damages cell-membrane integrity, which affects a lichen’s ability to photosynthesize at low atmospheric SO_2 concentrations in sensitive species such as in beard lichens (*Usnea*), whereas tolerant lichens such as Monk’s Hood Lichen (*Hypogymnia physodes*) will survive continuous to high exposure. Air pollution studies using lichens as indicators in the 1960s documented lichen desert effects in Montreal, an urban industrial area and Sudbury and Wawa, Ontario, both with iron ore mines that emitted sulphur dioxide into the atmosphere. Nowadays, with strict governmental emissions controls, more subtle effects of air quality exposure are measured in the lichen tissues. Lichen community indicators for nitrogen-containing pollutants such as ammonia can be detected in the macrolichen community structure by using the presence/absence of certain lichen species that tell researchers what areas are being affected.

Lichens have several other wide and varied uses today such as a food source for caribou that eat ground-dwelling reindeer (*Cladonia*) lichens in winter. Some squirrels make nests from witch's hair (*Bryoria*) lichens. Icelandmoss Lichen (*Cetraria islandica*) can be ground into flour and used to thicken soups and stews. Model railroads often use reindeer (*Cladonia*) lichens as trees or shrubs on the train platform.

Richness and diversity in Canada

Relative to most other groups covered in this report, the species richness of macrolichens is high across the country (figure 6 and table 6), peaking in British Columbia (573 macrolichens). The flora of British Columbia is particularly diverse within a Canadian context, as 99 species of macrolichens that occur there are found nowhere else in Canada. Macrolichens in British Columbia have been intensively collected relative to other provinces and territories except southern Ontario; this may be reflected in the high diversity of BC macrolichens. Other factors affecting macrolichen richness and diversity are large areas of provinces and territories that are under-collected and when collection sites are mapped show no collections at all. These areas can be targeted for future inventory work.

Species spotlight - Wolf Lichen

Wolf Lichen (*Letharia vulpina*) is a brightly coloured chartreuse or yellow-green fruticose or shrubby lichen. The tufted thallus or lichen body is characterized by having granular soredia or asexual reproductive structures on angular, pitted branches. This light-loving lichen is widespread and common, growing on the twigs, branches and trunks of conifers, especially Lodgepole Pine (*Pinus contorta*). Often, Wolf Lichen will form a prominent display partially covering standing dead trees and snags. In winter, skiers will notice this lichen as its vivid chartreuse colour forms a sharp contrast with the snow, forest and bright blue sky.

The common Wolf Lichen is widespread in the mountains throughout southern British Columbia and Alberta, the Pacific Northwest and California, whereas the Brown-eyed Wolf Lichen (*Letharia columbiana*), a less common species, tends to have a more restricted distribution in high elevation subalpine forests. Wolf Lichen is the sorediate half of the lichen species pair with Brown-eyed Wolf Lichen that has large brown, fringed fruiting bodies or apothecia and lacks soredia. Of species pairs, the sorediate species, e.g. Wolf Lichen, tends to have a broader geographic distribution throughout its range as its options for dispersal are much greater than the apotheciate species where the fungal spore must find the "right" alga before a lichen can be formed. DNA evidence has disclosed six species of wolf lichens (*Letharia*) in North America that includes the two species above. Some of the species are cryptic and cannot be distinguished morphologically from one another.

The common and scientific name "Wolf Lichen" comes from the bright yellow vulpinic acid, an example of a secondary substance present in most lichens that gives the distinctive yellow colour to this lichen. Wolf Lichen was used traditionally to poison foxes and wolves in northern Europe. Vulpinic acid is not only poisonous to all meat eaters but also to insects and molluscs, but surprisingly is not harmful to rabbits and mice.

Species spotlight - Boreal Felt Lichen

Boreal Felt Lichen (*Erioderma pedicellatum*) is an epiphytic foliose lichen found in the temperate and boreal northern hemisphere. It is a leafy lichen, light grey when dry to greyish green when wet. The lichen has a covering of fine white hairs on the upper surface and a mat of dense white hairs on the under surface. Mature thalli will have small round reddish fruiting bodies on the upper surface. This lichen is part of a group of lichens known as cyanolichens because the photosynthesizing partner is a cyanobacterium. In the case of Boreal Felt Lichen, the cyanobacterium is in the genus *Scytonema*.

Boreal Felt Lichen is a globally endangered species known from only a few places in the world. Populations are threatened by air pollution and commercial forestry, and continue to decline. Recent finds in Alaska may be the most promising news for the future of the species. Boreal Felt Lichen is one of the most sensitive species to human disturbances and thus acts as an early warning of ecosystem impacts.

The world population of Boreal Felt Lichen has been listed as critically endangered by the International Union for the Conservation of Nature (IUCN). In Canada, the Atlantic population, which includes Nova Scotia and New Brunswick, was listed as Endangered by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) in 2002. The boreal population on the Island of Newfoundland was listed as Special Concern by COSEWIC in 2002.

Newfoundland hosts the largest population of Boreal Felt Lichen in the world with numbers, according to forestry personnel, probably in the tens of thousands. Unfortunately, recent population modeling indicates the population is declining. The exact causes are unknown, but researchers suspect that acid rain may be a contributing factor. They also suggest that introduced Moose (*Alces americanus*), with an expanding high density population, have browsed young Balsam Fir (*Abies balsamea*), the main substrate of Boreal Felt Lichen, to the extent that (regeneration of) habitat is limited. Further, old-growth Balsam Fir, the ideal habitat for Boreal Felt Lichen, is the target of commercial forestry operations.

The known population of Boreal Felt Lichen in Nova Scotia is 180 individuals and although new sites are being found by researchers, old sites are disappearing. One third of lichens monitored since 2005 are dead or dying. At least two locations have been lost due to adjacent forestry operations, although there may be others. Other thalli have been lost due to grazing, possibly by introduced gastropods. Like other cyanolichens, Boreal Felt Lichen is extremely sensitive to air pollution and in North America is predicted to decline in the next 12 years. Large areas of Nova Scotia continue to receive levels of acid deposition in excess of critical loads.

Erioderma pedicellatum is believed to be extirpated from New Brunswick. Despite recent searches by local lichenologists, it hasn't been found in the province since the early 20th century. Acid rain and fog and air pollution have likely degraded the habitat to the point where it cannot survive there.

In August, 2007, several thalli of Boreal Felt Lichen were collected in Denali National Park and Preserve and later in Denali State Park in Alaska. This was the first collection in western North America and marks a significant range extension. The significance of this find is yet to be understood. The possibility of a larger population in western North America increases the hope for the survival of this species.

Boreal Felt Lichen is sensitive to anthropogenic impacts. The species provides an early warning of human perturbations on the environment. The fate of the global population of Boreal Felt Lichen is uncertain. With only two locations in Europe, survival there is uncertain. Air pollution and commercial forestry continue to be threats in eastern Canada. Only increased effort to reduce threats can ensure the survival of this species.

Results of general status assessment

Just over half of Canada's 861 species of macrolichens have Canada ranks of Secure (53%, 468 species; figure 6 and table 6), while 12% have Canada ranks of May Be At Risk (100 species), 8% have Canada ranks of Sensitive (68 species) and 1% have Canada ranks of At Risk (five species). Less than 1% of macrolichens have Canada ranks of Extirpated (one species) and none have Canada ranks of Extinct. Less than 1% of macrolichen species have a Canada rank of Exotic (one species). Finally, 25% of Canada's macrolichens have Canada ranks of Undetermined (211 species) and 1% have Canada ranks of Not Assessed (seven species).

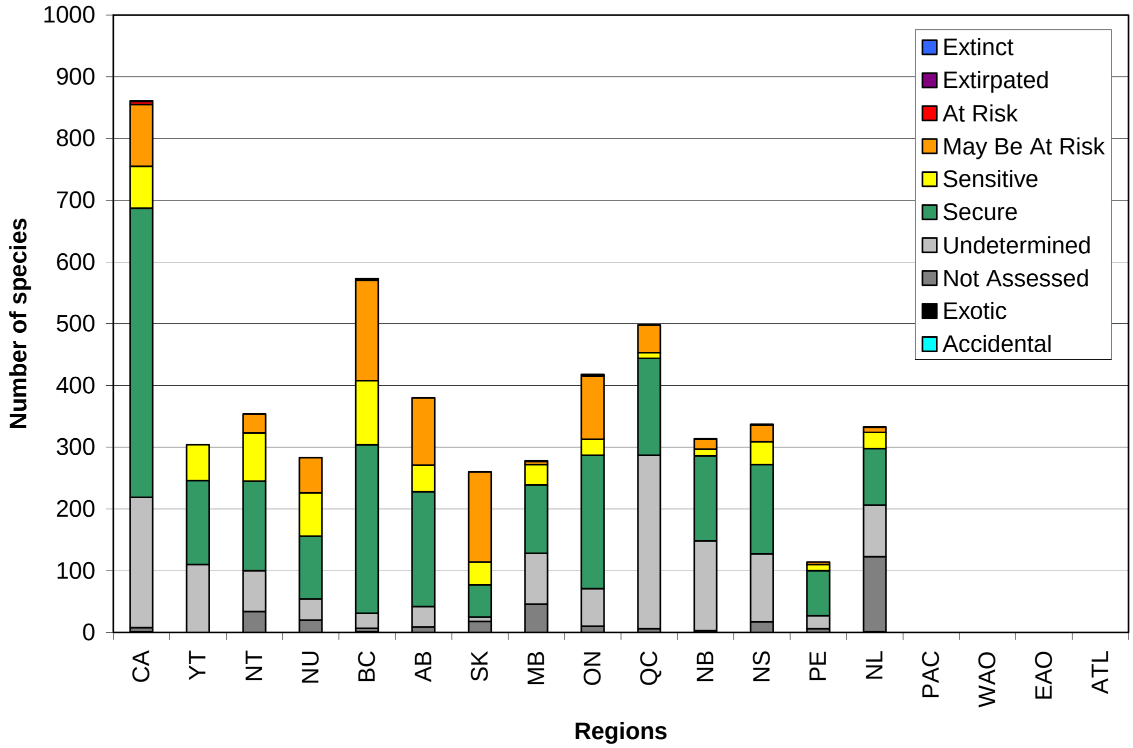

Figure 6. Results of the general status assessments for macrolichen species in Canada in the *Wild Species* 2010 report.

Table 6. Canada ranks of macrolichen species as determined by the National General Status Working Group.

	Canada rank	Number and percentage of species in each rank category
0.2	Extinct	0 (0%)
0.1	Extirpated	1 (0%)
1	At Risk	5 (1%)
2	May Be At Risk	100 (12%)
3	Sensitive	68 (8%)
4	Secure	468 (53%)
5	Undetermined	211 (25%)
6	Not Assessed	7 (1%)
7	Exotic	1 (0%)
8	Accidental	0 (0%)
	TOTAL	861 (100%)

Threats to Canadian macrolichens

The major threats to Canadian macrolichens are loss of habitat and poor air quality. Loss of habitat can be caused by many different events such as forestry practices, especially clear-cutting and old-growth forest removal; both practices are especially detrimental to lichen biodiversity. Lichens that lack asexual propagules have limited dispersal abilities and may not recolonize disturbed habitats. Growth rates of macrolichens are slow, so once the lichen is removed from its environment, it may take years to return, if ever. Strong wind storms such as along coastal regions, can destroy lichen habitat and the lichens themselves. Flooding will kill lichens if water levels remain high for extended periods of time. Mining operations and clear-cut logging alter habitat so that the microenvironments of lichens will no longer support a rich diversity of lichens.

Air quality in industrial areas is compromised by emissions such as sulphur dioxide, nitrogen oxides and a variety of other noxious compounds. Most lichens are sensitive to these pollutants and will eventually die. Acid rain is harmful to lichens and has caused habitat degradation in Atlantic Canada. Lichens in heavily populated areas in southern Canada are most at risk as their habitat is altered by urban development and air quality.

Conclusion

This general status assessment of 861 of Canada's macrolichens is an important achievement, involving input from lichenologists, professional biologists and government departments across the country using the most current information to assess the distribution and general status of the macrolichens of Canada. This first compilation of macrolichens is a starting point for awareness of lichens and impetus to continue to build the lichen lists in all provinces and territories in Canada. The macrolichen list will form a platform for further lichen inventories, especially in locations where knowledge is lacking, that will lead to new lichens discovered and new lichens described as well as expanding the provincial and territorial lists to include crustose or microlichens.

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Mosses

Bryophyta - Non-vascular terrestrial plant lacking roots, but having primitive stems and leaves, and a simple reproductive cycle.

Quick facts

- There are more than 10 000 moss species in the world; 1006 have been identified in Canada.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (76%) of mosses in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 13% have Canada ranks of Sensitive and 9% have Canada ranks of May Be At Risk. Ten mosses species (2%) have a Canada rank of At Risk following a detailed assessment by COSEWIC.

- One moss species that used to be present in Canada is now Extinct globally and one species is recorded as Extirpated from Canada.

- Exotic species are rare in the moss flora of Canada and so far include only four species.

- The smallest mosses are *Seligeria* and measure less than 2 mm tall. The largest freestanding mosses in Canada are *Polytrichum*, sometimes reaching 25 cm in height.

Haller’s Apple Moss, *Bartramia halleriana* © René Belland

Background

Mosses belong to the plant division *Bryophyta* (Bryophytes), which includes also liverworts and hornworts. Bryophytes are green land plants which, like all plants produce food via photosynthesis (using sunlight to convert carbon dioxide to simple sugars). While this activity is common to all plants, mosses are classified with the bryophytes (as opposed to vascular plants) because of their simple reproductive cycle and their simple anatomical structure. Features that distinguish mosses are the simple structure of the leaves and stems, lack of woody tissue, external fertilization, small size, lack of roots, and reproduction by spores.

The reproductive cycle of mosses is an important distinguishing character. The cycle comprises of two phases, a sperm and egg producing (“gametophyte”) phase, and a spore producing phase (“sporophytes”). The sporophyte phase is most familiar to people as it is the green plant and comprises most of the lifetime of the moss. Under the right conditions, the gametophyte will produce male and female reproductive structures that hold sperm and eggs. These structures can be on the same plant or on different plants. When mature, the sperm are released from the male structures (called “antheridia”) and swim to the female structures (called “archegonia”) where they fertilize an egg. The fertilization of an egg marks the beginning of the sporophyte phase. This phase is totally dependent on the gametophyte relying on it for nutrients and water. A mature sporophyte consists of a stalk with a spore capsule at the end of the stalk. The capsule contains spores that are eventually released and disperse by air currents. Upon landing in suitable habitat, the spore will germinate and develop into a new gametophyte, thus completing the cycle.

There are several hurdles that a moss must overcome to successfully produce spores and colonize new territory. The first is that water is required for the fertilization of the eggs by sperm. Thus, in arid regions or habitats where rainfall is scarce or infrequent, mosses may not have the opportunity to develop sporophytes, and thus will not produce spores. An equally important hurdle is that successful spore dispersal depends on luck and timing. The challenge is to get the spores dispersed into air currents and carried to a potential germination site. For instance, the spores of species growing in open habitats can more readily enter air currents than those of species that grow in dense woods or rock crevices. But, as already stated, spore dispersal is only a small part of successful colonization. Once a spore reaches its destination, landing in a suitable habitat or on a suitable substrate will largely determine if the spore can germinate. The majority of mosses require very specific environmental conditions (both climatic and physical) to grow and reproduce, and usually, the requirements for germination are the most stringent.

A physiological feature that distinguishes mosses from other plants is the ability of many species to withstand periods of desiccation (lack of water) and to recover from them upon rehydration. This phenomenon is known as “desiccation tolerance”, and it is exemplified also by some insects and many lichens. Desiccation tolerance is an adaptation in response to the inability of mosses to actively manage water loss from leaves and stems and other exposed structures. The issue of desiccation is compounded by the lack of roots in mosses. Without roots to absorb moisture from the soil, it is not possible to replenish water lost from the leaves by evaporation. As a result, the moisture content of mosses closely follows humidity cycles. Significantly, it is only when mosses are wet or moist that they grow since water is a necessary requirement for metabolism. When the moss’ habitat or substrate dries out, so does the moss and all growth stops. Contrast the mosses plight with that of vascular plants, most whose leaves are typically 10’s of cells thick and have thick waxy cuticles that prevent water loss, and that have extensive root systems to replenish their water needs.

While desiccation tolerance might be viewed as a disadvantage, this adaptation has in fact enabled mosses to diversify into many habitats and onto a wide variety of substrates that are impossible to be colonized by rooted plants. For instance, mosses are able to grow directly on rocks and or the barks of trees, two microhabitats that are outside the realm of vascular plants. Furthermore, the ability to grow on such substrates has allowed mosses to avoid competition with the larger and taller vascular plants, against whom they would certainly lose in any bid to acquire sunlight and water.

The small size of most mosses has played a large role in where they grow. The smallest mosses in Canada can be less that 1.5 millimetres tall (e.g., *Seligeria* spp.), whereas the largest may be some peat mosses (*Sphagnum*) that attain lengths of one meter when growing in bog pools. However, most mosses are of moderate size, varying from four millimetres to 20 centimetres. Their small size is due to the fact that mosses do not produce woody tissue that would provide the rigidity and strength to enable the plants to attain any height. Nonetheless, like desiccation tolerance, the small size of mosses can be viewed as advantageous, allowing them to grow in “microhabitats” where most vascular plants cannot. As a result, mosses can grow as epiphytes on trees and shrubs, in small rock crevices, or in animal burrows, to name a few. Where mosses dominate ecosystems, for example, in bogs, it is because they have changed the physical environment of such ecosystems to suit their needs.

The microhabitat preference of mosses has promoted much research into their use as indicators of environmental conditions in some ecosystems, such as forests. Their indicator value is useful in the management of natural resources.

Although small in size, mosses play an important role is many ecosystems. Mosses are dominant plants in many wetlands, peatlands, boreal forests, and coastal rainforest. In these systems they play an important role in controlling runoff and nutrient cycling, and influencing soil temperatures. Mosses are especially important in peatlands, which are an important ecosystem in the boreal zone of Canada. Peatlands consist of deep deposits of partly decomposed peat moss which in many places may have resulted from more than 5000 years of accumulation! Mosses are also conspicuous in the Arctic, where they predominate in many habitats, and where their diversity exceeds that of vascular plants.

Since some mosses produce an abundance of very small spores (<10 µm) that can be carried by wind, it is generally assumed that mosses are widespread and can be found everywhere. Moreover, if the species shows a gap in its range, then this gap is thought by some to likely be due to the species having been overlooked in that area. This could not be farther from the truth. Mosses show geographical patterns similar to those found in vascular plants. Fewer that 25 species in Canada are truly found worldwide where they occur on every continent.

About 40% of Canadian mosses are boreal species that can be found and recognized in many northern ecosystems of the northern hemisphere. About half of the boreal mosses are circumboreal species, meaning that they show continuous ranges throughout much of the boreal forests. Temperate mosses are of equally importance as boreal mosses in Canada's moss flora. Like the boreal mosses, many of the mosses with distributions primarily associated with the temperate zone have wide ranges in this biome in the northern hemisphere. Montane mosses, as the name implies, occur only in mountainous regions of eastern and western Canada. Some species in this group have a truly unique ecology, being restricted to growing in snow beds that persist through most of the summer, and in some years, surviving under snow for the entire growing season. Arctic mosses range primarily at latitudes above tree line, and most occur also in arctic regions outside of Canada. A number of species have wider ranges and occur at southerly latitudes where they are found primarily in mountainous regions. Endemics are species with very restricted ranges, usually found only in one well defined region. Few mosses are endemic only to Canada and most are North American endemics whose ranges include a portion of Canada. The majority occur mainly along the coast of British Columbia or in southernmost Ontario and Québec.

Most mosses have little economic importance. The exception to this is the moss genus *Sphagnum*, which is commonly known as peat moss. *Sphagnum* is harvested in several provinces where it is processed and packaged for many uses. Certainly the most common usage is as a soil conditioner for gardens. However, the uses of peat are much more varied, and it is also used as a medium for growing mushrooms, as an industrial chemical absorbent, and as the main absorbent in some brands of feminine napkins. The importance of *Sphagnum* as an effective absorbent has long been known, as much research was conducted on this moss during World War I to determine which species were most effective for use in surgical dressing.

In recent years, mosses have been harvested in the rainforests of the Pacific Coast for use as packing material to help retain soil moisture in plant pots. Mosses absorb water quickly and release it slowly. In coastal rainforests where mosses are abundant, their removal by large scale harvesting by the horticultural industry can have significant effects on drainage by increasing erosion and leading to slope instability.

Status of knowledge

The study of mosses has a long history in Canada. The first catalogue of Canadian mosses is that of John Macoun's (dating from the late 1800's), who summarized records from many of the early collectors and botanists. Since Macoun, there has been considerable research and inventory on mosses in many parts of the country. While much of the early and middle part of the 20th century, the study of mosses included a large floristic component while the latter part of the 1900's has seen a shift toward more ecological studies geared to understanding the effects of human activities on moss diversity in an effort to effect better management of some ecosystems, but especially the boreal ecosystem. This information has been supplemented by many surveys conducted for rare mosses in areas that are planned for resource extraction or other industrial uses.

Relative to the status and distribution of vascular plants, mosses are not as well known, owing to the fewer numbers of specialists studying the group. Nonetheless, the overall distributions of mosses in Canada are well known, lacking only in detailed knowledge of species occurrences at smaller geographic scales. Most regions in Canada have been well explored and documented, and this is especially true in British Columbia, the southern Rocky Mountains, some of the Arctic Islands, southern Ontario and Québec, the island of Newfoundland, and much of the Maritimes. However, information on moss diversity and distribution in large regions is generally lacking. These regions include Manitoba, large parts of the Prairies ecosystem, much of the mainland Northwest Territories and Nunavut, large parts of northern Québec and Labrador, and some Arctic Islands.

Richness and diversity in Canada

Relative to some groups covered in this report, the species richness of mosses is generally high across the country (figure 7), peaking in British Columbia (760 species) and high also in Québec (578 species), Newfoundland and Labrador (531 species), Ontario (522 species), and Alberta (522 species). The lowest diversity is in Prince Edward Island (204 species), followed by Saskatchewan (286 species) and Manitoba (335 species). Richness of mosses is closely tied to landscape diversity, with regions endowed with a high diversity of landforms and climates having the highest diversity. Lack of inventory work also impacts diversity and in some areas of the country the mosses are poorly known. As previously mentioned, this is particularly true of some northern regions but especially in southern Nunavut, the eastern Northwest Territories, and surprisingly, the province of Manitoba. These areas should be priorities to be targeted for future inventory work.

Species spotlight - Stairstep Moss

Stairstep Moss (*Hylocomium splendens*) is one of three feathermosses. Feathermosses are some of the easiest mosses to know by name, not only because their growth form resembles that of a feather, but also because they are large and conspicuous. Of the three feathermosses, the growth form of Stairstep Moss is most distinctive and not seen in other mosses. The plant consists of large, lacy fronds that emanate at intervals along a main stem, giving the plant a "stairstep" appearance. Of particular interest is that only one frond is produced each year, at the apex of the stem. This gives a way to determine a minimum age of a plant, with each frond representing one year of growth; this is akin to growth rings on a tree. As noted, counting fronds gives a minimum age for the plan; after six to seven years, older fronds will have decomposed beyond recognition. Nevertheless, under ideal conditions, it is sometimes possible to find plants with eight to nine years of growth.

The growth form and size of stairstep also makes this plant useful as an indicator of average moisture conditions in forests where it is found. The length of the stem between the fronds corresponds directly to moisture levels in the environment, with longer stem lengths indicating higher moisture availability. This provides an easy way for researchers to compare long term moisture conditions in contrasting forest types. The size of stairstep is also a good indicator of moisture. In the coastal rainforests of British Columbia for instance, the fronds of stairstep often measure 3 cm across, whereas in the drier boreal forests of the continental interior, the fronds will be only 1-1.5 cm.

Species spotlight - the dung mosses

Dispersal of spores for almost all mosses is dependent on being carried by air currents to reach new colonization sites. One family of moss, the dung mosses (family *Splachnaceae*), has evolved interesting adaptations that allow them to take advantage of a different means of dispersing spores - by insects!

In Canada, the *Splachnaceae* consists of four genera: *Aplodon*, *Tayloria*, *Tetraplodon*, and *Splachnum*. The species in these genera are specialized to grow on dung, carrion, stomach pellets of birds, and bone. As can be imagined, because of their size and random locations on the landscape, these substrates are not easy "targets" for spores to land on when spores are carried by air. However, flies and other insects are naturally attracted to these substrates. Consequently, dung moss species have evolved adaptations to attract insects so that spores may be attached to them and carried to the appropriate substrate. The adaptations involve the spore capsule, and include enlargement and development of coloration of the neck of the capsule (hypophysis), the production of odiferous (smelly) capsules, and the development of sticky spores dispersed in clumps.

These adaptations in *Splachnaceae* allow the mosses to continually colonize new substrates as they appear in an area, ensuring their long time survival there.

Results of general status assessment

Wild Species 2010 marks the first national assessment for mosses in Canada. Results of this assessment indicated that 58% of mosses have Canada ranks of Secure, while 10% have Canada ranks of Sensitive and 7% have Canada ranks of May Be At Risk (figure 7 and table 7). Ten mosses species (2%) have a Canada rank of At Risk following a detailed assessment by COSEWIC. One moss species (*Neomacounia nitida*) that used to be present in Canada is now Extinct globally. One species of moss (*Ptychomitrium incurvum*) is recorded as Extirpated from Canada. To date, four Exotic moss species have been recorded in Canada.

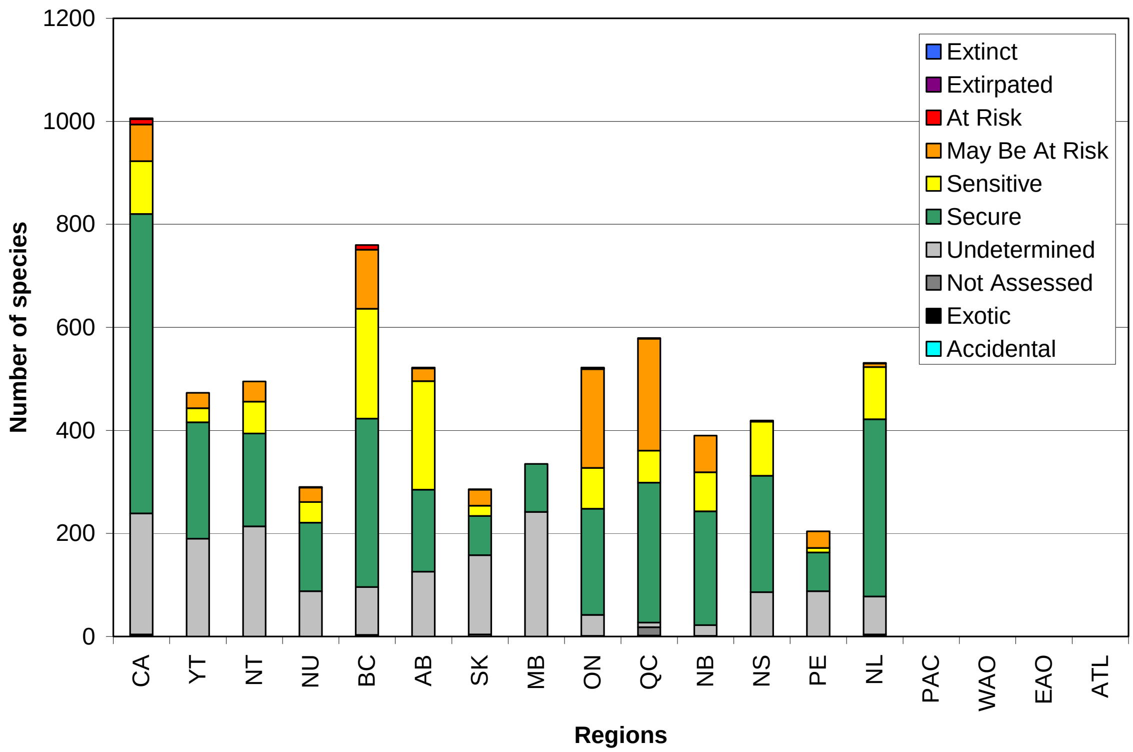

Figure 7. Results of the general status assessments for moss species in Canada in the *Wild Species* 2010 report.

Table 7. Canada ranks of moss species as determined by the National General Status Working Group.

	Canada rank	Number and percentage of species in each rank category
0.2	Extinct	1 (0%)
0.1	Extirpated	1 (0%)
1	At Risk	10 (2%)
2	May Be At Risk	71 (7%)
3	Sensitive	103 (10%)
4	Secure	581 (58%)
5	Undetermined	235 (23%)
6	Not Assessed	0 (0%)
7	Exotic	4 (0%)
8	Accidental	0 (0%)
	TOTAL	1006 (100%)

Threats to Canadian mosses

Like many other plants and animals, mosses require both terrestrial and aquatic habitats in order to survive and maintain their populations. Most mosses are vulnerable to both habitat degradation and destruction as a result of human activities. Important habitats for mosses at risk include forests, cliffs, as well as wetlands. Climate warming is often considered as a threat to many wildlife species, and certainly this factor will have an effect on mosses. Of special importance in this regard are many mosses that grow in mountains or in arctic regions in association with late snow beds or habitats whose existence relies on colder temperatures.

Conclusion

This first general status assessment of the mosses of Canada is an important achievement as it marks a milestone in highlighting the importance of mosses in Canada. With more than 1000 species, this is one of the largest groups of organisms assessed. While the report shows that at least 7% of mosses have a Canada Rank of May Be At Risk, it also shows that the status of a large proportion (23%) are ranked Undetermined. The latter is a reflection how much more there is to learn about this fascinating group and this first assessment provides a solid foundation for further research and conservation effort.

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Vascular plants

Tracheophyta - Plants characterized by the possession of true roots, shoots and leaves containing specialized vascular tissue through which liquids are conducted.

Quick facts

- There are over 352 000 species of vascular plants in the world. More than 95% of vascular plants are flowering plants, also called angiosperms (e.g. grasses, orchids, maple trees). The other types of vascular plants are gymnosperms (cone-bearing trees, e.g. pine trees, spruce trees) and seedless plants (e.g. ferns, horsetails). 5111 species of vascular plants have been found in Canada.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (71%) of vascular plants in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 13% have Canada ranks of Sensitive, 12% have Canada ranks of My Be At Risk and 4% have Canada ranks of At Risk.

- A total of 25 species of vascular plants that used to be present in Canada are now Extirpated from the country.

- A large number of species (1252) of vascular plants are Exotic. They represent 24% of all species of vascular plants found in the Canada. This is the highest proportion of any taxonomic group covered in this report.

- All vascular plants were also assessed in the report *Wild Species* 2005. In the 2000 report, only ferns and orchids were assessed.

Drooping Trillium, *Trillium flexipes* © Thomas G. Barnes

Background

Plants play a critical role in maintaining life on earth, because they are one of the few groups of organisms that can make their own food. Through the chemical process of photosynthesis involving green chlorophyll pigments, plants use energy from the sun to convert water and carbon dioxide into oxygen and sugar, which is used as a food source by plants, and by plant-eating animals. Therefore, plants produce two of the resources that all animals need to survive; food and oxygen. In addition, plants play important roles in the environment by helping to regulate climate, providing habitat for wildlife, contributing to nutrient cycles and soil creation, improving air and water quality, and reducing soil erosion.

Most familiar plants, such as ferns, orchids, herbs, grasses, shrubs and trees are vascular plants. All vascular plants have roots, leaves and a vascular system, which transports water, sugars and nutrients throughout the plant.

Vascular plants are the largest group of plants in the world, and form the dominant vegetation over much of the earth's landmass.

The oldest vascular plants are the seedless plants, including the ferns, club mosses, and horsetails. Seedless plants dominated the world in the Carboniferous period, approximately 300 million years ago. Dead plants from this period formed coal beds from which coal is still mined today. All seedless plants reproduce using spores. For more information about seedless plants, please consult the ferns section in the *Wild Species* 2000 report.

From the seedless plants evolved two groups of seed plants; the cone-bearing plants (the gymnosperms, e.g. pine trees, spruce trees) and the flowering plants (the angiosperms, e.g. grasses, orchids, maple trees, oak trees). As their name suggests, seed plants use seeds rather than spores for reproduction. Seeds are simply embryos surrounded by a seed coat, which protects the embryo from drought, extreme temperatures and other harsh conditions. Most seeds also contain a food source for the developing plant. Angiosperms surround their seeds with an additional layer of protection, the fruit. The fruit protects the seeds, and often provides a mechanism for spreading them over long distances. Fruits can be fleshy (e.g. blueberries, cranberries) or dry (e.g. the keys of the Sugar Maple, *Acer saccharum*, are actually a type of fruit!).

Vascular plants are usually rooted to one spot, so finding a mate for reproduction can be challenging. Gymnosperms produce pollen (male sex cells) and eggs in separate male and female cones. The pollen is released into the air and carried by the wind to a female cone, where it will fertilize the eggs. The process of transporting pollen from the male cone to the female cone is called "pollination". The chance of successful pollination is fairly small, so gymnosperms produce large amounts of pollen to increase the chance that some of it will meet with a female cone of the same species.

In angiosperms, all the sex organs are located within flowers (although male and female organs are not necessarily found within the same flower, or even on the same plant). While some angiosperms rely on wind pollination (e.g. grasses), most rely on animal pollinators such as insects, birds and even bats, to carry pollen between their flowers. Angiosperms attract potential pollinators with brightly coloured petals, sweet fragrances, or by producing nectar. Some species have evolved to attract very specific pollinators. For example, the main pollinators of the Cardinal Flower (*Lobelia cardinalis*) are hummingbirds, which are attracted to the plant by the bright red flowers. The long, narrow tube of cardinal flowers are the perfect shape for a hummingbird to insert its bill and retrieve the nectar. As the hummingbird feeds, pollen is deposited on its head; then the pollen will be brushed off at the next flower, where it will fertilize the eggs. By attracting specific types or species of pollinators, plants can increase the chances that their pollen reaches another flower of the same species.

Plants are amazing chemical factories that make a variety of different products, from defensive chemicals that protect the plant from predation, disease and parasites, to hormones that control the plant's growth. Humans have long known that many of the chemicals that plants produce have useful medicinal properties. For example, Common Yarrow (*Achillea millefolium*) is a well known traditional cure for staunching wounds and treating fevers, colds and other ailments. Today, Common Yarrow can be found in more than 20 pharmaceutical products sold in Canada.

Status of knowledge

The study of plants has a long history in Canada, from Aboriginal Peoples who relied on plants for food, shelter, clothing, raw materials and medicines, to the early European settlers, some of whom became famous botanists (e.g. Catherine Parr Trail, John Macoun). Much of today's research is centered on plants that are important for agriculture, forestry or medicine, using new genetic and molecular tools to study a huge variety of topics including plant physiology, genetics, biotechnology and interactions between plants and pests.

Relative to other species groups covered in this report, the distribution and status of many vascular plant species in Canada is fairly well known, particularly in southern Canada. Nevertheless, systematic surveys are still uncovering new information, such as the recent discovery of a new tree species for Canada, the Swamp Cottonwood (*Populus heterophylla*, see species spotlight for more details). As well as discovering new species, systematic surveys improve information on the distribution and abundance of vascular plants. For example, in New Brunswick, the first systematic rare plant survey of the upper St. John River in 2001 and 2002, showed that two species of grasses, Mat Muhly (*Muhlenbergia richardsonis*) and Little Bluestem (*Schizachyrium scoparium*), thought to be rare in the province, were actually more common than previously believed.

The distribution of vascular plants in remote areas, and in northern Canada is less well known. This is partly because fewer people (both amateurs and professionals) are studying plants in these regions, despite the presence of unique plant communities and endemic species found nowhere else on earth. In addition, many plant specimens from northern Canada have been housed in national collections in southern Canada. While some of these collections have been well documented and catalogued (e.g. the National Herbarium at the Canadian Museum of Nature), others have only recently been fully catalogued to reveal new information about northern vascular plants.

Plant ecology is the study of how plants interact with, and are affected by, the world around them; both the physical world (e.g. temperature, soil type, light levels) and the "biological" world (interactions with other plants, animals, fungi, etc). This is important for understanding a variety of topics, including plant distribution, how plants survive in different environments, and plant productivity. Plant ecology also helps researchers understand how changes in the environment (e.g. climate change, invasion of exotic species) might affect plant communities. For example, researchers in Quebec, working on grasses in pastureland, have shown that exposure to increased levels of carbon dioxide can influence plant succession (changes in community composition through time) and species richness. Knowledge of plant ecology can also help conserve and restore native plant communities. For example, Canadian researchers are working on restoring surface vegetation to bogs that have been mined for peat. This is the first step in restoring mined bogs back to a functioning ecosystem.

Richness and diversity in Canada

Relative to other groups covered in this report, the species richness of vascular plants is high across the country (figure 8), peaking in British Columbia (2127 native species). The flora of British Columbia is particularly diverse within a Canadian context, because many hundreds of native species of vascular plants found there are found nowhere else in Canada. Other regions of Canada known as centers of vascular plant species diversity, and for concentrations of endemic plants include the Central Yukon Plateau, Ellesmere and Baffin Islands, the sand-dune region of Lake Athabasca, Saskatchewan, and the Gulf of St. Lawrence.

The proportion of Exotic plant species is high across the country, but tends to be highest in the provinces of eastern Canada (22% to 36%) and lowest in the territories (2% to 10%).

Species spotlight - Showy Lady's-slipper

The Showy Lady's-slipper (*Cypripedium reginae*) is known as the "queen" of the orchids. This species has beautiful pink and white flowers, and grows up to 80 cm tall. Each flower has three petals, the lowest of which is folded into a pouch. This pouch is said to resemble a slipper, giving the lady's-slipper orchids (genus *Cypripedium*) their name. Showy Lady's-slippers require very nutrient-rich soil and are found in fens and wet, open forests throughout eastern and central Canada.

Like all orchids, Showy Lady's-slippers have an intriguing and complicated life cycle. Orchid seeds are very small, almost microscopic, and do not contain a food source to nourish the germinating seed. In order to survive and grow, the seed must come in to contact with a specific soil fungus, which provides enough nutrients for it to grow into a small plant. Once the plant produces leaves, it can make its own food through photosynthesis. However, it can take up to 12 years for this slow-growing plant to produce flowers! To protect the plant from hungry predators during its long life cycle, the shoots and leaves of Showy Lady's-slippers are covered in stinging hair-like structures. The stinging "hairs" strongly discourage invertebrates, and larger predators, such as White-tailed Deer (*Odocoileus virginianus*), from eating the plant.

Showy Lady's-slippers are pollinated by insects, typically small bees or flies. However, unlike many other angiosperms, lady's-slipper orchids do not produce nectar to attract visiting insects. Instead, insects are thought to be attracted to the flower by the colours and patterns of its petals, and by its scent. Once an insect enters the flower, it becomes trapped within the folded lower petal, or slipper. To escape, the insect must push past the pistil (the female part of the flower), where pollen is brushed off the insect's body, to fertilize the eggs. Finally, the insect pushes past the stamen (the male part of the flower), where it picks up more pollen, before leaving the flower.

Due in part to its long, complicated life cycle, this species is particularly vulnerable to increased rates of adult and juvenile mortality. For example, harvesting by gardeners and other collectors has led to the loss of entire populations, despite the fact that this species does not grow at all well in artificial settings. Other concerns include habitat loss, changes in the abundance or distribution of insect pollinators or soil fungi, and trampling of the inconspicuous young shoots and soil compaction by humans attracted by the beauty of the adult plants. Showy Lady's-slipper is widespread and locally common in much of eastern Canada, and has a Canada rank of Secure.

Species spotlight - carnivorous plants

Carnivorous plants have the fascinating ability to capture and kill insects and other small animals. Carnivorous plants live primarily in nutrient-poor bogs and other habitats with acidic or wet soils. In these habitats, essential nutrients such as nitrogen, are difficult to obtain, so carnivorous plants supplement their nutrient supply by digesting the insects that they capture. Interestingly, this ability has evolved separately in several different plant families, so modern carnivorous plants are quite varied in structure and the methods they use for capturing insects.

There are 20 different species of carnivorous vascular plants in Canada, representing four different groups; pitcher plants (genus *Sarracenia*, one species), sundews (genus *Drosera*, five species), butterworts (genus *Pinguicula*, three species) and bladderworts (genus *Utricularia*, 11 species). Each group has its own unique method of capturing and digesting prey. For example, sundews have modified leaves covered in red, hair-like structures, each topped with a glistening drop of sticky mucus. Insects are attracted by the sundew's colourful appearance and sweet-smelling secretions, but once they step onto a leaf, they quickly become stuck. As the insect struggles, more hairs are drawn inwards to help secure the insect. Glands on the hairs secrete enzymes, which digest the prey, allowing the leaf to absorb the nutrients.

The most complicated active traps developed by carnivorous plants are found in the bladderworts, which capture tiny aquatic prey. Aquatic bladderworts float freely in shallow water, without the benefit of roots to draw nutrients from the soil. Their leaves are very finely divided and contain numerous tiny chambers or bladders. Each bladder operates as a vacuum trap, whose door is triggered by hair-like structures. When a prey item brushes against the "hairs", the door of the bladder flips open and the prey is sucked into the trap along with the surrounding water. Once inside, the prey is digested and the water is pumped back outside, re-creating the vacuum and leaving the trap ready for the next victim. Amazingly, the door of the bladder trap opens in less than 0.002 seconds, one of the fastest response-times in the plant world!

The majority of Canada's carnivorous plants are ranked Secure, but two species (California Butterwort, *Pinguicula macroceras*, and Yellowish-white Bladderwort, *Utricularia ochroleuca*) have a Canada rank of Sensitive and one species (Thread-leaved Sundew, *Drosera filiformis*) has a Canada rank of At Risk.

Carnivorous plants are an important component of nutrient-poor wetlands across the country. The most important threat is habitat destruction through peat mining, wetland drainage and succession, although collecting for the commercial plant trade is also a concern for all species of carnivorous plants.

Species spotlight - Tamarack

Tamarack (*Larix laricina*), also known as Hackmatack or Eastern Larch, is found in every province and territory of Canada, and is the official tree of the Northwest Territories. Tamaracks are unusual in the plant world because they are deciduous conifers! Like other conifers, Tamaracks have cones and needle-like leaves, but each autumn, their soft, flexible needles turn a beautiful golden colour and fall off, to be replaced again in spring.

Tamaracks grow in a range of soil conditions, but are typically found in cold, poorly drained soils, in bogs and other peatlands. A small to medium sized tree, mature plants are typically 15 to 23 m tall, up to 40 cm in diameter and can live for about 150 to 180 years. Tamaracks are common in the boreal forest and are considered a very cold-hardy tree. In order to survive the cold winter, Tamaracks take advantage of a process called “extracellular freezing”. As water freezes, ice-crystals are formed, which can damage cells irreparably. However, during extracellular freezing, water is squeezed out of the tree’s cells and stored in the air spaces between the cells. This prevents the cells from being damaged when ice crystals form, allowing Tamaracks to survive as far north as the tree line.

Although Tamaracks are not an important commercial species, they are harvested and sold to make pulp products. The hard, rot-resistant wood is also used to make poles, fence posts and railway ties, while in the past its roots were prized for shipbuilding. Aboriginal Peoples have used Tamarack for many purposes including food, medicine, and construction of canoes and snowshoes. The roots can be used for weaving bags and for sewing bark canoes together.

A variety of animals feed on the leaves, cones, seeds or bark of Tamarack trees, such as Sharp-tailed Grouse (*Tympanuchus phasianellus*), American Black Bear (*Ursus americanus*), Snowshoe Hare (*Lepus americanus*), North American Porcupine (*Erethizon dorsatum*), and Red Squirrel (*Tamiasciurus hudsonicus*). Major pests of the Tamarack include Larch Sawfly (*Pristiphora erichsonii*) and Eastern Larch Beetle (*Dendroctonus simplex*).

Tamarack has a Canada rank of Secure and is also ranked Secure in each of the provinces and territories. Its native cousins, Subalpine Larch (*Larix lyallii*) and Western Larch (*Larix occidentalis*), found only in Alberta and British Columbia, also have Canada ranks of Secure.

Species spotlight - Swamp Cottonwood

In 2002, while carrying out a biological survey of Bickford Woods in southern Ontario, researchers were amazed to discover a new species for Canada. This new species is not small or easily overlooked, but is in fact a stand of over 60 mature trees, growing up to 27 m tall! The new species is Swamp Cottonwood (*Populus heterophylla*), a deciduous tree belonging to the willow family (family *Salicaceae*) and closely related to the poplars, aspens and other cottonwoods (genus *Populus*). Swamp Cottonwood occurs fairly commonly in the southeast United States, but is rarer in the northeast United States.

This medium-sized deciduous tree grows up to 40 m in height, in wet soils of swamps and floodplains. Its leaves are large and rounded, and the bark is thick and rough with a reddish colour. As with other poplars, Swamp Cottonwood flowers grow very early in the spring, even before the leaves appear. The flowers grow in the form of dangling catkins and each tree has either male or female flowers, never both. Pollen is carried by the wind from male to female flowers, where the eggs are fertilized and seeds begin to develop. The seeds are light with hair-like tufts, so they can be carried by wind or float on water. The Swamp Cottonwood's habitat is often flooded early in the spring, when the seeds are produced. The seeds fall into the water and float until water levels decrease, at which time the seeds are deposited on the wet soil where they can germinate and grow. Swamp Cottonwoods grow best in open areas with little shade, and they are often found along the edges of swamps and rivers. Mature trees occur in low numbers throughout the species' range and are not a major component of any forest-type.

The story of the discovery of the Swamp Cottonwood in Canada reminds us that there are many discoveries still to be made about Canadian wildlife, even in densely populated regions like southern Ontario. Due to its highly restricted Canadian distribution and small population size, Swamp Cottonwood has a Canada rank of May Be At Risk.

Results of general status assessment

Of the 5111 species of vascular plants found in Canada, 53% have Canada ranks of Secure (2635 species, figure 8 and table 8), while 9% have Canada ranks of Sensitive (484 species), 9% have Canada ranks of May Be At Risk (444 species) and 3% have Canada ranks of At Risk (136 species). Less than 1% of vascular plant species have Canada ranks of Extirpated (25 species), and none have Canada ranks of Extinct. In total, 24% of vascular plant species have a Canada rank of Exotic (1252 species), the highest proportion of Exotic species of any species group covered in this report. Finally, 2% of Canada's vascular plant species have Canada ranks of Undetermined (112 species), and less than 1% have Canada ranks of Not Assessed (23 species).

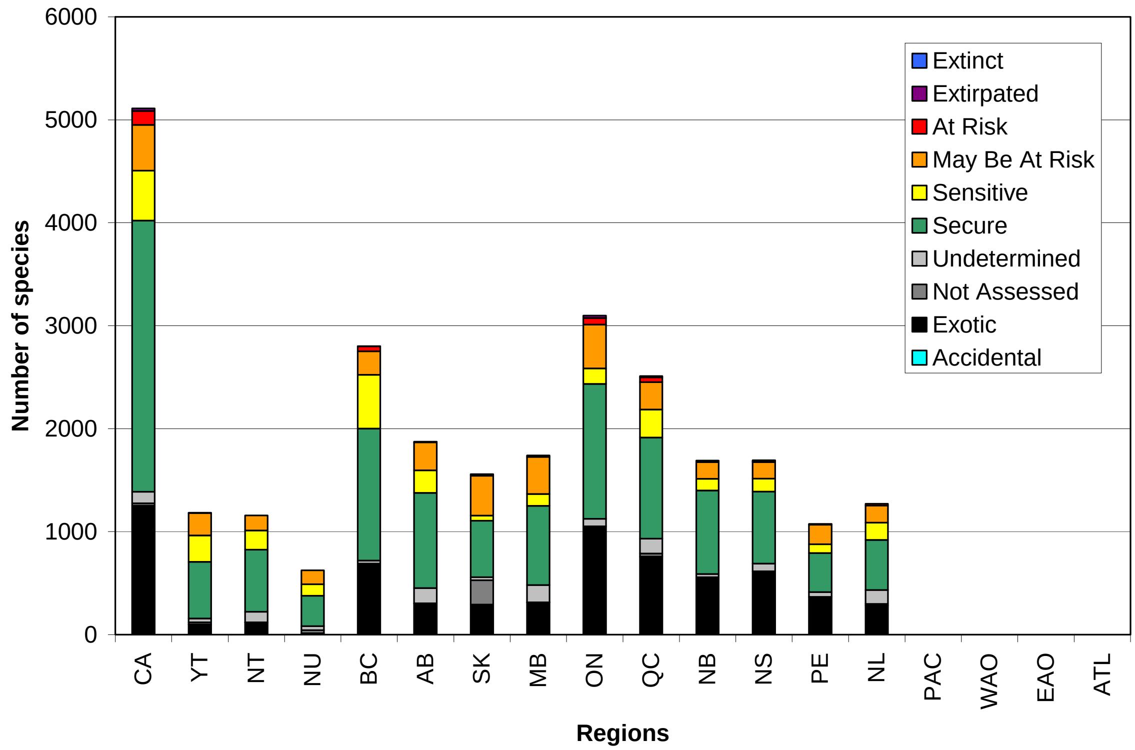

Figure 8. Results of the general status assessments for vascular plant species in Canada in the *Wild Species* 2010 report.

Comparison with previous Wild Species reports

The *Wild Species* 2010 report marks the second national assessment of all vascular plants in Canada (all species of vascular plants were first assessed in the report *Wild Species* 2005). However, ferns and orchids were also assessed in the *Wild Species* 2000 report. We then present first a comparison of all species of vascular plants, and then present trends specifically for ferns and orchids.

All species of vascular plants

The rank category of May Be At Risk had the greatest decrease in the number of species of vascular plants, while the category of Secure had the greatest increase in the number of species (table 8). The category Exotic had also a great increase in the number of species. Since the last assessment in 2005, a total of 37 species were added to the national list of vascular plants.

A total of 495 changes were made in the Canada ranks for all species of vascular plants since the last assessment in 2005. Among these changes, 54 species had an increased level of risk, 132 species had a reduced level of risk, 84 species were changed from or to the ranks Undetermined, Not Assessed, Exotic or Accidental, 131 species were added, and 94 species were deleted. Main reasons for changes were improved knowledge of the species and taxonomic changes (table 9).

Table 8. Changes in the number of vascular plant species over time in each rank category as determined by the National General Status Working Group.

	Canada rank	Years of the *Wild Species* reports			Average change between reports	Total change since first report
		2000	2005	2010		
0	Extinct / Extirpated	-	22 (0%)	25 (0%)	-	+3 species
1	At Risk	-	110 (2%)	136 (3%)	-	+26 species
2	May Be At Risk	-	552 (11%)	444 (9%)	-	-108 species
3	Sensitive	-	460 (9%)	484 (9%)	-	+24 species
4	Secure	-	2572 (51%)	2635 (53%)	-	+63 species
5	Undetermined	-	112 (2%)	112 (2%)	-	Stable
6	Not Assessed	-	30 (1%)	23 (0%)	-	-7 species
7	Exotic	-	1216 (24%)	1252 (24%)	-	+36 species
8	Accidental	-	0 (0%)	0 (0%)	-	Stable
	TOTAL	-	5074 (100%)	5111 (100%)	-	+37 species

Table 9. Reasons for changes in the status of vascular plant species between the last assessment and the current report.

Code	Description	Number of species	Proportion of all changes
B	Change due to biological change in species' population size, distribution or threats.	42	8%
C	Change due to new COSEWIC assessment.	37	7%
E	Change due to error in previous ranks.	8	2%
I	Change due to improved knowledge of the species.	301	61%
P	Change due to procedural changes.	5	1%
T	Taxonomic change.	102	21%
	TOTAL	495	100%

Note: For vascular plants, the ranks of a large number of species changed since the last assessment. We then present only a summary of the reasons for changes.

Fern species only

Ferns were first assessed in the report *Wild Species* 2000. A total of three species were added to the national list since this first assessment (table 10). Over time, the highest increase was observed in the number of species ranked as May Be At Risk (+3 species) and the highest decrease was observed in the number of species ranked as Secure (-2 species).

Table 10. Changes in the number of fern species (part of the vascular plants) over time in each rank category as determined by the National General Status Working Group.

	Canada rank	Years of the *Wild Species* reports			Average change between reports	Total change since first report
		2000	2005	2010		
0	Extinct / Extirpated	0 (0%)	0 (0%)	0 (0%)	Stable	Stable
1	At Risk	3 (2%)	5 (4%)	5 (4%)	+1 species	+2 species
2	May Be At Risk	18 (15%)	24 (19%)	21 (17%)	+2 species	+3 species
3	Sensitive	20 (16%)	15 (12%)	19 (15%)	-1 species	-1 species
4	Secure	79 (65%)	78 (63%)	77 (61%)	-1 species	-2 species
5	Undetermined	0 (0%)	0 (0%)	1 (1%)	+1 species	+1 species
6	Not Assessed	0 (0%)	0 (0%)	0 (0%)	Stable	Stable
7	Exotic	2 (2%)	2 (2%)	2 (2%)	Stable	Stable
8	Accidental	0 (0%)	0 (0%)	0 (0%)	Stable	Stable
	TOTAL	122 (100%)	124 (100%)	125 (100%)	+2 species	+3 species

Orchid species only

Orchids were first assessed in the report *Wild Species* 2000. In total, one species was removed from the national list since this first assessment (table 11). Over time, the highest increase was observed in the number of species ranked as Sensitive (+4 species) and the highest decrease was observed in the number of species ranked as May Be At Risk (-4 species).

Table 11. Changes in the number of orchid species (part of the vascular plants) over time in each rank category as determined by the National General Status Working Group.

	Canada rank	Years of the *Wild Species* reports			Average change between reports	Total change since first report
		2000	2005	2010		
0	Extinct / Extirpated	0 (0%)	1 (1%)	1 (1%)	+1 species	+1 species
1	At Risk	7 (9%)	8 (11%)	8 (10%)	+1 species	+1 species
2	May Be At Risk	10 (13%)	5 (7%)	6 (8%)	-2 species	-4 species
3	Sensitive	6 (8%)	10 (13%)	10 (13%)	+2 species	+4 species
4	Secure	50 (64%)	49 (64%)	49 (64%)	-1 species	-1 species
5	Undetermined	0 (0%)	0 (0%)	0 (0%)	Stable	Stable
6	Not Assessed	0 (0%)	0 (0%)	0 (0%)	Stable	Stable
7	Exotic	4 (5%)	3 (4%)	3 (4%)	-1 species	-1 species
8	Accidental	1 (1%)	0 (0%)	0 (0%)	-1 species	-1 species
	TOTAL	78 (100%)	76 (100%)	77 (100%)	-1 species	-1 species

Threats to Canadian vascular plants

With such a wide diversity of vascular plant species in Canada, it is not surprising that the threats to vascular plants are similarly varied. As with other species groups, habitat loss and degradation are major factors affecting plants. Habitat loss occurs when natural habitats are replaced with land-uses such as agriculture or housing, or as a result of natural processes such as succession, fire or flooding. Habitat degradation can occur in many forms, including pollution, changes in drainage patterns, or trampling by humans or animals. Over-harvesting is another threat for some species, particularly for plants that are valued for their beauty (e.g. Showy Lady's-slipper), or for medicinal properties.

In recent years, the impact of exotic species has become recognized as a serious threat to native wildlife. Exotic plants can compete with native plants for space to grow and for resources. A well known example of this is Purple Loosestrife (*Lythrum salicaria*), which was introduced from Europe in the 1800s and has altered many wetlands from systems of high plant diversity to systems dominated almost entirely by a small number of exotic species. This change affects many species including the mammals, reptiles, amphibians and invertebrates that rely on wetlands for survival. For example, Muskrats (*Ondatra zibethicus*) will not eat Purple Loosestrife, and many birds will not nest in it. Other exotic species, such as the Flowering Rush (*Butomus umbellatus*), represent important threats along highways in eastern Canada, and some have no natural enemies. Exotic species can also introduce new diseases, which can reduce the health of native plants. Another problem is hybridization, in which an exotic plant interbreeds with a native plant, weakening its gene pool. The native Red Mulberry (*Morus rubra*), ranked At Risk, has declined partly due to hybridization with the exotic White Mulberry (*Morus alba*). Every year, millions of dollars are spent on trying to control exotic species like Nodding Thistle (*Carduus nutans*), Purple Loosestrife, Spotted Knapweed (*Centaurea stoebe*) and European Buckthorn (*Rhamnus cathartica*) in natural habitats.

Conclusion

This general status reassessment of all Canada's 5111 species of vascular plants is an important achievement, involving input from botanists across the country, using the most current information to assess the distribution and general status of Canada's vascular plants. The results of this reassessment indicate that the majority of vascular plant species in Canada are considered Secure, although many species vascular plants have Canada ranks of May Be At Risk and At Risk. The results also highlight the large proportion of exotic species;

24% of Canada's vascular plants are ranked Exotic, a much higher proportion than for any other group covered in this report.

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Molluscs

In the *Wild Species* 2010 report, only one taxonomic group of molluscs is assessed, the freshwater mussels from the class of bivalves.

Freshwater mussels

Unionoida - Order of molluscs belonging to the class Bivalvia. Like other bivalves, freshwater mussels are soft-bodied, non-segmented invertebrates, with a pair of hinged shells and a muscular foot.

Quick facts

- Worldwide, there are nearly 1000 species of freshwater mussels, 54 of which have been found in Canada.
- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, only 39% of freshwater mussels in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 25% have Canada ranks of Sensitive, 24% have Canada ranks of At Risk and 12% have Canada ranks of May Be At Risk.
- One species of freshwater mussel is extirpated from Canada.
- Freshwater mussels live in lakes and rivers throughout Canada, where they improve water clarity and quality by filtering algae and bacteria from the water.
- Over two-thirds of freshwater mussels in the United States are at risk of extinction, according to *Rivers of Life*, a NatureServe report that summarizes the status of freshwater species.
- Freshwater mussels have a unique life cycle, during which the larvae must attach to the fins or gills of a host species, usually a fish, before they can mature into adults.

Kidneyshell, *Ptychobranchus fasciolaris* © Todd Morris

Background

Freshwater mussels (order *Unionoida*) are fascinating animals with a unique method of reproduction and an important role in maintaining water quality. Freshwater mussels are molluscs belonging to the class *Bivalvia*; other bivalves include oysters and scallops. Like all bivalves, freshwater mussels are soft-bodied invertebrates living within a shell made of two halves joined by a hinge. Freshwater mussels live in the bottom of streams, rivers and lakes throughout Canada, reaching their greatest diversity in the lower Great Lakes region.

The simple body of a freshwater mussel includes a mantle, which produces the hard, calcareous shell, a muscular foot, used for moving around in the sediment, and gills which are used to obtain oxygen from the water. Freshwater mussels feed on plankton and other organic particles suspended in the water by filtering water through their gills and extracting food particles. Waste is deposited on the sediment around the mussel, providing food for bottom-feeding invertebrates and fishes. By removing algae and bacteria from the water during feeding, freshwater mussels improve the clarity and quality of the water. Freshwater mussels also play important roles in nutrient cycles, food webs and in mechanically oxygenating the sediment in which they live, making them an important component of freshwater ecosystems.

The reproductive cycle of freshwater mussels is unique, firstly because the female broods fertilized eggs within her shell, rather than releasing them to drift on the current, and secondly because the specialized larvae, or glochidia, are parasitic, meaning that they require a vertebrate host to reach maturity. Once the glochidia have hatched and been released by the female, they find a host and clamp onto its gills or fins, forming a small cyst where they will develop into juvenile mussels. When development is complete, the juvenile mussels drop from the host down to the sediment, where they grow and mature into adult mussels. Each species of freshwater mussel has specific host species necessary for completion of its life cycle. For example, the Alewife Floater (*Anodonta implicata*), found in Quebec, New Brunswick and Nova Scotia, relies on the Alewife fish (*Alosa pseudoharengus*) for development of its young. One freshwater mussel, the Salamander Mussel (*Simpsonaias ambigua*), can only mature on the gills of a Mudpuppy (*Necturus maculosus*), an aquatic salamander.

Many freshwater mussel species have developed unique strategies to increase the chances of their young finding a suitable host. For example, the female Wavyrayed Lampmussel (*Lampsilis fasciola*) tempts a potential host close using a lure made of a special flap of tissue that resembles a small fish. Kidneyshell (*Ptychobranchus fasciolaris*) uses a slightly different kind of lure; the Kidneyshell's glochidia are wrapped in packages that resemble small fish. Each package is released into the water, and when a real fish bites into the package, the glochidia are released to attach to the new host.

The complexities of the fascinating life cycle of freshwater mussels result in a low reproductive rate, meaning that very few eggs survive to grow into adult mussels. To help compensate for this, freshwater mussels produce vast numbers of eggs; up to several thousands at a time. In addition, freshwater mussels often have a long life span to allow them to reproduce many times. Some species can live for more than 50 years!

Freshwater mussels are an important tool for monitoring the health of aquatic systems because they are sensitive to a wide range of environmental factors including the health and diversity of local fish communities and levels of dissolved oxygen in the water. Therefore, a reduction in the diversity or abundance of freshwater mussels, or a shift in the freshwater mussel community towards species that are tolerant of poor water quality, can indicate a negative change in the ecosystem. Freshwater mussels have also been used to study contaminants in aquatic systems. For example, the Eastern Elliptio (*Elliptio* *complanata*) has been used to examine the spatial patterns of polychlorinated biphenyls (PCB) contamination in the Detroit River, Ontario.

Status of knowledge

Much of our knowledge of the life cycle of freshwater mussels comes from attempts to propagate mussels for the pearl button industry, which was important in the United States in the early 1900s. While this early research provided an outline of the typical life cycle of freshwater mussels, relatively little is known about the life cycle of specific freshwater mussel species. For example, the host(s) of many Canadian freshwater mussels remain unknown. Also, little is known about the juvenile stage of the life cycle, between the time that the mussel first drops from its host until the time when it reaches sexual maturity.

Recent research into freshwater mussels has focused on the impacts of Zebra Mussels (*Dreissena polymorpha*) and Quagga Mussels (*Dreissena bugensis*), on native freshwater mussels. Like native freshwater mussels, Zebra Mussels and Quagga Mussels belong to the class *Bivalvia*, but they belong to a different order (order *Veneroida*) than native freshwater mussels, and are not ranked in this general status assessment. Zebra Mussels and Quagga Mussels are native to Europe, but both species have been accidentally introduced into the Great Lakes in recent years. Zebra Mussels fasten onto the shells of native freshwater mussels, sometimes in huge numbers, interfering with normal functions such as feeding and burrowing. This can eventually lead to the death of the infested mussel. Since the introduction of Zebra Mussels, the abundance and distribution of native freshwater mussel communities in the Great Lakes system has declined rapidly. In fact, Zebra Mussels have seriously undermined the population stability of several native freshwater mussel species including the Northern Riffleshell (*Epioblasma torulosa*), the Kidneyshell and the Round Pigtoe (*Pleurobema sintoxia*), all of which have Canada General Status Ranks (Canada ranks) of At Risk. The Quagga Mussel is thought to adversely affect native freshwater mussels, but less is known about the impacts of the Quagga Mussel than the Zebra Mussel.

Recent concerns over declines in freshwater mussels have stimulated new research into the distribution and abundance of native freshwater mussels, particularly in the Great Lakes region. Historical records of freshwater mussel occurrence within this area have been compiled into a single database to facilitate the comparison of current and historical distribution patterns, while new surveys of mussel habitat in this region have highlighted the critical importance of certain rivers and lakes in supporting populations of At Risk species. For example, the Sydenham River, Ontario, is a major refuge for several freshwater mussel species that are protected under Canada's endangered species legislation, the *Species at Risk Act*, including the Snuffbox (*Epioblasma triquetra*), Rayed Bean (*Villosa fabalis*) and the Salamander Mussel.

Systematic surveys in other parts of the country have also improved our knowledge of freshwater mussel abundance and distribution. For example, a recent survey in southern Manitoba showed evidence of declining diversity and abundance of freshwater mussels in a range of habitats, while surveys of the Saint John River system in New Brunswick in 2001 and 2002 revealed the existence of large populations of the Yellow Lampmussel (*Lampsilis cariosa*), previously thought to be extirpated from the province.

Richness and diversity in Canada

A total of 54 species of freshwater mussels has been found in Canada. Freshwater mussels are found in every province and territory of Canada, but species richness is highest from Manitoba east to Nova Scotia (figure 9). Within Canada, 19 species of freshwater mussels are found only in Ontario, including 14 species with Canada General Status Ranks (Canada ranks) of At Risk or May Be At Risk. The high diversity of freshwater mussels in Ontario, particularly in the Lake St. Clair and western Lake Erie region, is related to patterns of recolonization since the last period of glaciations.

Species richness of freshwater mussels in the west and northwest is generally low (figure 9), but four of the six species of freshwater mussels in British Columbia are found nowhere else in Canada. Similarly, the only freshwater mussel in the Yukon, the Yukon Floater (*Anodonta beringiana*), is found nowhere else in Canada.

Species spotlight - Yellow Lampmussel

Yellow Lampmussels (*Lampsilis cariosa*) are recognised by their waxy, egg-shaped, yellow shells. As is typical of many mussel species, the females tend to have fatter, more rounded shells than the males, providing space for the female to brood eggs within her shell. Yellow Lampmussels are found in medium to large rivers along the east coast of North America from Georgia to Nova Scotia. Like other freshwater mussels, they feed on plankton and other organic matter filtered from the water. The host fishes for their parasitic larvae are probably White Perch (*Morone americana*) and Yellow Perch (*Perca flavescens*).

Yellow Lampmussels are only known from two river systems in Canada; the Sydney River on Cape Breton Island, Nova Scotia and the Saint John River drainage system in New Brunswick. Until recently, it was feared that Yellow

Lampmussels had been lost from New Brunswick, but surveys of the lower Saint John River drainage and its tributaries in 2001 and 2002 found a large, well-established population, potentially numbering more than 1 million individuals. The size of this population contrasts sharply with the status of the species elsewhere, as it is listed as Threatened or Endangered throughout much of its range in the United States. Due to its limited occurrence, this species has a Canada rank of Sensitive.

Species spotlight - Round Hickorynut

Round Hickorynuts are medium-sized freshwater mussels, with distinctive round, brown shells. Once widespread in the lower Great Lakes, Round Hickorynuts were probably extirpated from Lake Erie as early as 1950, due to declining water quality. Following the invasion of the Zebra Mussel in the late 1980s, Round Hickorynuts also disappeared from off-shore waters of Lake St. Clair. In 1999, a previously unknown population of Round Hickorynuts was discovered in a shallow-water refuge on the north shore of Lake St. Clair. This refuge harbours 22 species of freshwater mussels, several of which were feared to have been lost from the lake. Zebra Mussel densities in this refuge are relatively low, probably due to the harsh conditions in this shallow area of the lake, where mussels are exposed to fluctuating water levels and ice scour. The only other known Canadian population of Round Hickorynuts is in the Sydenham River, where they exist in very low numbers and are exposed to the negative effects of poor water quality and siltation. In all, Round Hickorynuts have been lost from approximately 90% of their former Canadian range.

The host fish for the Round Hickorynut is suspected to be the Eastern Sand Darter (*Ammocrypta pellucida*), although this has not been confirmed. Eastern Sand Darters (Canada rank in 2005: At Risk) have declined in number in recent years, due to declining water quality and increased siltation, but still exist in both Lake St. Clair and the Sydenham River.

The long-term prospects for Round Hickorynuts in Canada are uncertain, due to the abundance of Zebra Mussels in Lake St. Clair and the apparent sensitivity of Round Hickorynuts to poor water quality. In addition, further population declines or range reductions of the suspected host fish, the Eastern Sand Darter, may also prove detrimental to the Round Hickorynut. Round Hickorynuts have a Canada rank of At Risk.

Results of general status assessment

A total of 54 freshwater mussels has been found in Canada, of which just over one-third (37%, 20 species) have a Canada rank of Secure (figure 9 and table 12). A further 33% have Canada ranks of At Risk (12 species) and May Be At Risk (six species) and 24% have Canada ranks of Sensitive (13 species). One species, the Dwarf Wedgemussel (*Alasmidonta heterodon*) has a Canada rank of Extirpated (2%). Finally, 4% have Canada ranks of Undetermined (two species).

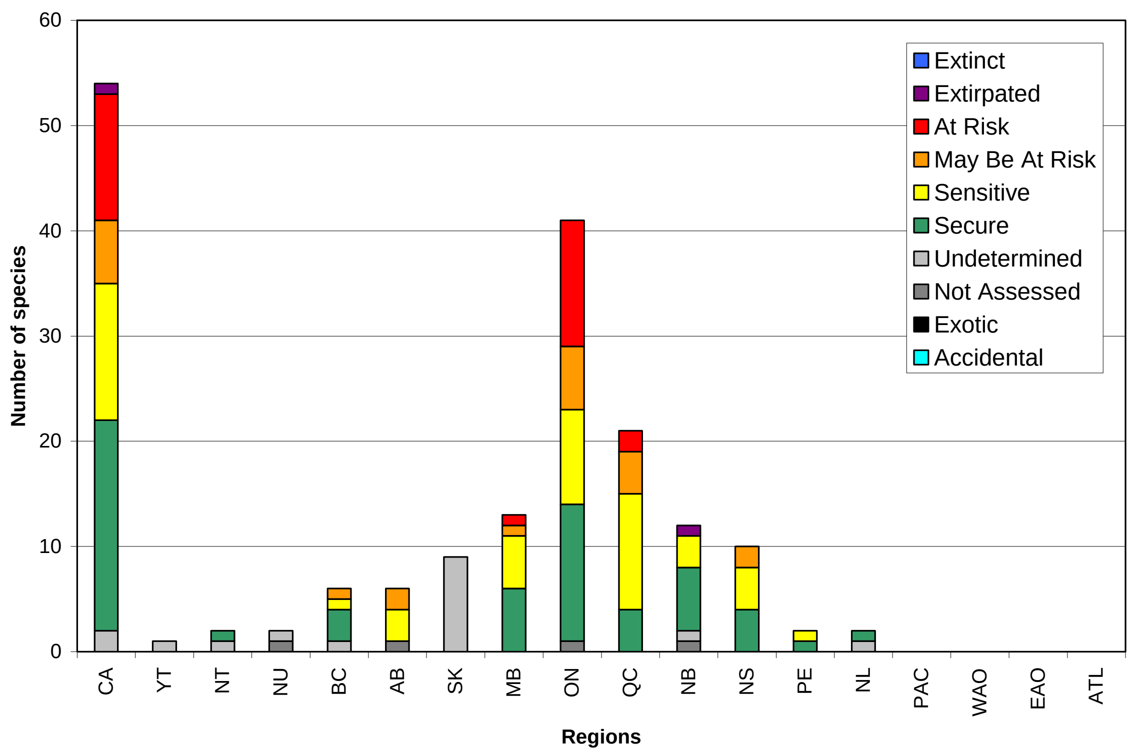

Figure 9. Results of the general status assessments for freshwater mussel species in Canada in the Wild Species 2010 report.

Comparison with previous Wild Species reports

Since the assessment done in 2005 for freshwater mussels, the category At Risk had the highest increase in number of species (table 12). These species came mostly from the category of May Be At Risk. A total of eight species had a change in their Canada rank since the last assessment. Among these changes, four species had an increased level of risk, one species had a reduced level of risk, two species were changed from or to the ranks Undetermined or Not Assessed, and one species was deleted. Main reasons for changes were new COSEWIC detailed assessments and improved knowledge of some species (table 13).

Table 12. Changes in the number of freshwater mussel species over time in each rank category as determined by the National General Status Working Group.

	Canada rank	Years of the *Wild Species* reports			Average change between reports	Total change since first report
		2000	2005	2010		
0	Extinct / Extirpated	-	1 (2%)	1 (2%)	-	Stable
1	At Risk	-	8 (15%)	12 (22%)	-	+4 species
2	May Be At Risk	-	9 (16%)	6 (11%)	-	-3 species
3	Sensitive	-	15 (27%)	13 (24%)	-	-2 species
4	Secure	-	19 (34%)	20 (37%)	-	+1 species
5	Undetermined	-	2 (4%)	2 (4%)	-	Stable
6	Not Assessed	-	1 (2%)	0 (0%)	-	-1 species
7	Exotic	-	0 (0%)	0 (0%)	-	Stable
8	Accidental	-	0 (0%)	0 (0%)	-	Stable
	TOTAL	-	55 (100%)	54 (100%)	-	-1 species

Table 13. Reasons for changes in the status of freshwater mussel species between the last assessment and the current report.

Scientific name	English name	2005 Canada rank	2010 Canada rank	Reason for change
Anodonta beringiana	Yukon Floater	6	5	(I) Survey efforts were made in Yukon.
Anodonta californiensis	California Floater	3	-	(I) New work has determined that this species does not occur in BC and records were misidentified individuals of *Anodonta nuttalliana*.
Anodonta oregonensis	Oregon Floater	3	4	(I) Improved knowledge of the species.
Elliptio crassidens	Elephantear	5	2	(I) Improved knowledge of the species.
Ligumia nasuta	Eastern Pondmussel	2	1	(C) COSEWIC assessment of Endangered in April 2007.
Quadrula quadrula	Mapleleaf	2	1	(C) COSEWIC assessment of Threatened in ON and Endangered in MB in April 2006.
Truncilla donaciformis	Fawnsfoot	2	1	(C) COSEWIC assessment of Endangered in April 2008.
Villosa iris	Rainbow	2	1	(C) COSEWIC assessment of Endangered in April 2006.

Threats to Canadian freshwater mussels

Freshwater mussels are potentially susceptible to a number of threats including habitat destruction, poor water quality, siltation, damming and channelization of streams and rivers, riparian and wetland alterations, and agricultural run-off. These threats may act directly on the mussel population or have an indirect impact through declines in the host fish species that are required to complete the mussel’s life cycle.

The introduction of the Zebra Mussel has had a dramatic impact on native freshwater mussel populations in recent years, causing sharp declines in the numbers and diversity of native freshwater mussels in the Great Lakes-St. Lawrence system and in other rivers and inland lakes that have been colonized by this invasive species. Although the affected drainages represent only a portion of the range of freshwater mussels in Canada, they are nonetheless host to some of the most abundant and diverse assemblages of freshwater mussels in the country. Therefore, although the affected area is small, the negative impact of Zebra Mussels on native freshwater mussels in Canada has been dramatic.

Conclusion

Freshwater mussels are less well known than many other groups of freshwater animals and there are few Canadian freshwater mussel experts. Nevertheless, recent declines in abundance and diversity have stimulated increased interest and research into Canadian freshwater mussels. New surveys have improved knowledge of the distribution and abundance of freshwater mussels and demonstrated the importance of key lake and river refuges for maintaining the diversity of freshwater mussels in Canada. This is a group containing a high proportion of species with Canada ranks of At Risk, and protecting the diversity of Canadian freshwater mussels will be a major challenge.

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Spiders

Araneae - Order of arachnids that include predatory species with eight legs, no antennas, two poison fangs, and usually two silk-spinning organs at the back end of the body; they spin silk to make cocoons for their eggs or webs to catch prey.

Quick facts

- There are approximately 40 000 known species of spiders in the world, of which 1379 have been found in Canada.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (86%) of spiders in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 7% have Canada ranks of Sensitive and 7% have Canada ranks of May Be At Risk. However, it should be noted that many of the spider species were ranked as Undetermined.

- A total of 70 species of spiders found in the wild in Canada are Exotic, meaning that they have been introduced by human activities.

- Spiders are found on every continent in the world except for Antarctica.

- Unlike most arthropods, spiders do not have extensor muscles in their limbs and instead extend them using hydraulic pressure.

Misumena vatia © Joanne Bovee

Background

Spiders (order *Araneae*) are the largest order of arachnids and rank seventh in total species diversity among all other groups of organisms. There are approximately 40 000 confirmed species of spiders world-wide (with an estimated total of 170 000) of which 1379 species have been confirmed in Canada. Spiders are found world-wide on every continent except for Antarctica, and live in almost all terrestrial and some aquatic habitats.

Spiders belong to a large group of organisms called arthropods. Arthropods have a hard outer coat called an exoskeleton that protects their soft insides. The bodies of arthropods are divided into sections. Unlike most arthropods, spiders have no extensor muscles in their limbs and instead extend their limbs using hydraulic pressure. The abdomens of all spiders include spinnerets that produce silk. The most well known use for the silk is in the production of spider webs, which are primarily used to catch prey and provide a protective retreat for the maker.

Most spiders have fangs through which venom is ejected. Although a few spiders are vegetarian when very young, all spiders are predators. They mostly prey on insects (flies, mosquitoes, grasshoppers, beetles, and butterflies) and on other spiders. The largest species of Canadian spiders are from the family *Pisauridea*; they can reach 15 cm including their legs and are able to feed on fishes and salamanders! Spiders capture prey by trapping it in their webs or by active hunting. Spiders that use webs detect their prey by movement in their webs. Most spiders have six or eight eyes, though some species have fewer or even none.

Most spiders will live for at most one or two years, however tarantulas and other mygalomorph spiders have been known to live up to 25 years in captivity. Male spiders of most species have a shorter life span than the female. During the reproductive phase, females weave silk egg-cases, each of which may contain hundreds of eggs. Females of some species care for their young by carrying them around and by sharing food. A small number of species are social, and will build communal webs.

Spider bites can be painful but only a very few spider species are known to be potentially dangerous to humans. Scientists are now researching whether some spider venoms could be used as medicines and as non-toxic pesticides.

Status of knowledge

Due to their interesting range of prey capture and reproductive behaviours and the associated complex morphology of various body parts, spiders have attracted attention for study by scientists. In fact, several international scientific journals are devoted primarily to the study of spiders. However, in spite of the interest in spiders, in general, they remain poorly known; probably less than a quarter of the world’s spider species have been described and named and life history is well known for only a few of these. In Canada, only a few habitats have been well sampled for spiders and new additions to the list of known Canadian spiders will undoubtedly occur.

Fortunately, good taxonomic literature exists for most spiders likely to occur in Canada. Because of this and the facts that spiders are important predators wherever they occur and generally show strong associations with particular habitats, spiders are favoured subjects for ecological study in North America, including as indicators of biodiversity. Spiders are becoming increasingly important to scientists, conservationists, and managers within Canada and elsewhere in the world.

Phidippus borealis © Joanne Bovee

Richness and diversity in Canada

The three provinces where the most species of spiders can be found are Ontario (751 species), British Columbia (701 species) and Quebec (679 species). Yukon, Northwest Territories and Nunavut generally have fewer species of spiders than the other provinces of Canada (figure 10). However, Prince Edward Island has the lowest number of spider species (38).

Species spotlight - Western Black Widow Spider

The Western Black Widow (*Latrodectus hesperus*) is a hairless species with a black shiny body about 6 mm long. On the underside of its very round abdomen there is usually, but not always, a distinctive red mark which can often be in the shape of an hourglass. Immature individuals usually have white or pink markings on their abdomen which occasionally will remain through adulthood. Black widow spiders are cobweb spiders, meaning their webs look like a tangle of lines with no pattern.

The Western Black Widow is found from southern Saskatchewan, Alberta and British Columbia in Canada and south all the way to Mexico. Individual spiders are occasionally brought into other areas of Canada in shipments of grapes from California.

Black widow spiders reproduce in the summer. Occasionally, after mating, the female black widow spider will eat the male! The females typically produce four to nine egg sacs at a time and each sac can contain from one-hundred to four-hundred individual eggs (of which approximately thirty eggs will survive). The baby spiders will take on average six to nine months to fully mature into adults. Female black widow spiders may live for several years, but the males will typically survive for a much shorter period. The black widow spider usually preys on insects, but will also feed on other spiders. Most prey become caught in the webs of the black widow spiders; spiders subdue the prey by wrapping them in silk threads and then biting them to inject their venom. The black widow begins feeding after the venom takes effect.

Black widows tend to prefer dark shaded habitats such as abandoned squirrel tunnels, wood piles and the underside of rocks in sunny outdoor areas. The spiders remain active until the first good frost, and then hibernate for the winter, reappearing in the spring when temperatures warm up. A hibernating spider drops its metabolic rate, tucks its legs into its body and remains huddled in a shelter during the coldest months of the year.

Contrary to popular belief, people are rarely bitten by black widow spiders, and in the unusual circumstance of an actual bite, the person seldom suffers serious damage. In very rare cases, bites may result in medical problems or even death. The Western Black Widow has a Canada Rank of Secure.

Species spotlight - Georgia Basin Bog Spider

The gnaphosid ground spider family is a relatively well known group with about 2000 recognized species world-wide. The Georgia Basin Bog Spider (*Gnaphosa snohomish*) is a very rare gnaphosid spider, known to exist only from a few sites in the Puget Sound / Georgia Basin area of northwestern Washington State and southwestern British Columbia. Current knowledge of the Georgia Basin Bog Spider indicates that it almost always selects peat and bog land as its habitat. The spiders follow a one year life cycle, overwintering before they are adults and then maturing late in the spring.

In British Columbia, researchers found what is considered to be the most substantial population in Burnaby, outside of Vancouver. The site of the find is an old commercial cranberry bog situated beside the Fraser River. The location is covered in peat and other mosses and overlain with cranberry bushes and various types of grasses. As of July 2007, the Burnaby site was redeveloped as a commercial cranberry bog. With little suitable habitat remaining (the site is surrounded by agricultural, commercial and industrial development), it is unknown whether any members of the Burnaby population of the Georgia Basin Bog Spider still exist.

Because of these confirmed threats to this very rare spider, the Georgia Basin Bog Spider was accepted for assessment by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC is preparing a report describing the status of the Georgia Basin Bog Spider which is anticipated to be completed in April 2012. The Georgia Basin Bog Spider has a Canada general status rank of May Be At Risk.

Results of general status assessment

This is the first assessment of spiders by the National General Status Working Group. The majority of Canada’s 1379 species of spiders have Canada ranks of Secure (714 species, 52%, figure 10 and table 14). However, many species of spiders are ranked as Undetermined (477 species, 35%). A total of 62 species (4%) are ranked as May Be At Risk and 56 species (4%) are ranked as Sensitive. Finally, 70 species of spiders (5%) are Exotic in Canada.

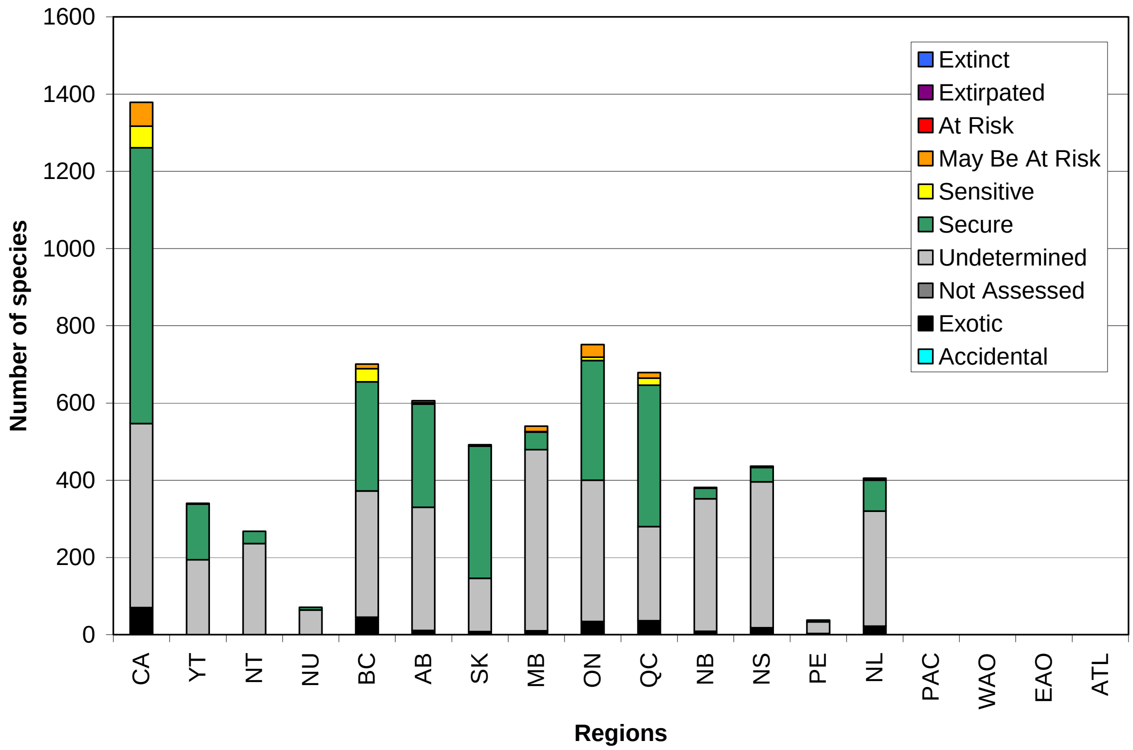

Figure 10. Results of the general status assessments for spider species in Canada in the *Wild Species* 2010 report.

Table 14. Canada ranks of spider species as determined by the National General Status Working Group.

	Canada rank	Number and percentage of species in each rank category
0.2	Extinct	0 (0%)
0.1	Extirpated	0 (0%)
1	At Risk	0 (0%)
2	May Be At Risk	62 (4%)
3	Sensitive	56 (4%)
4	Secure	714 (52%)
5	Undetermined	477 (35%)
6	Not Assessed	0 (0%)
7	Exotic	70 (5%)
8	Accidental	0 (0%)
	TOTAL	1379 (100%)

Threats to Canadian spiders

Many spider species show preferences for particular habitats. These spiders are vulnerable to habitat loss and disturbance due to natural succession, changes in drainage patterns, erosion control and other forms of habitat conversion, and climate change. Spiders are also very vulnerable to many pesticides.

Conclusion

Although spiders have attracted the attention of researchers and of the general public, most species are not very well studied. The ecology and distribution of these species need more studies. Much remains to be learned about their range and status in Canada.

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Insects

In the *Wild Species* 2010 report, 10 specific groups of insects have been studied, including odonates, predaceous diving beetles, ground beetles, lady beetles, bumblebees, black flies, horse flies, mosquities, some selected macromoths, and the butterflies. The National General Status Working Group has done assessments for these species and the results are presented in specific sections for each group of insects.

Odonates

Odonata - Order of insects that includes the dragonflies and damselflies. They are winged, carnivorous insects with brilliant metallic colouring, whose eggs are laid in water and which develop through an aquatic nymph (larval) stage.

Quick facts

- There are about 6500 species of odonates in the world, of which 211 can be found in Canada.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (78%) of odonates in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 11% have Canada ranks of May Be At Risk and 10% have Canada ranks of Sensitive. One odonate species (1%), the Rapids Clubtail (*Gomphus quadricolor*), has a Canada rank of At Risk based upon a COSEWIC assessment of Endangered.

- Odonates first emerged over 300 million years ago, about the same time as the reptiles first appeared, making the *Odonata* one of the oldest orders of insects alive today.

- The fossil dragonfly *Meganeura*, which lived about 250 million years ago, had a wingspan of over 50 cm, making it the largest odonate known!

- Dragonflies can have more than 25 000 lenses in each eye, giving them almost 360 degree vision.

Pygmy Snaketail, *Ophiogomphus howei* © Denis Doucet

Background

The order *Odonata* is divided into three sub-orders: the damselflies or *Zygoptera*; the dragonflies or *Anisoptera*; and the *Anisozygoptera*, which is represented by two living species, both found in Asia. Canada has a total of 211 odonate species, including 57 species of damselflies and 154 species of dragonflies. All odonates have two pairs of wings, long, slender bodies and large eyes. Dragonflies are usually larger and sturdier than damselflies, and tend to spread their wings horizontally at rest, whereas damselflies hold their wings pressed together over their back or only partly spread. Odonates depend on fresh water for successful reproduction and are found close to freshwater habitats of many different types, from tiny streams to bogs, marshes, fens, swamps and large rivers and lakes.

The odonate life cycle has three distinct phases: egg, larva and adult. Eggs are laid in or close to fresh water and hatch into aquatic larvae, which breathe using gills. The gills of dragonfly larvae are located in the rectal chamber, at the end of the digestive system. By squirting water through their gills, dragonfly larvae can use jet-propulsion to travel through the water. Damselfly larvae are more slender and appear more elegant than dragonfly larvae. They breathe with external gills, which look like feathers extending from the tip of the abdomen. One of the most unusual features of odonate larvae is the large, hinged lower lip, or labium. The labium acts rather like a grappling hook, shooting out at lightning speed to capture prey with dagger-like hooks. This unique capture device allows odonate larvae to be highly successful predators, feeding on a variety of aquatic organisms including other insects and even small fish. Odonate larvae in turn provide food for an amazing range of animals, from fish and crayfish to birds such as ducks.

Depending on the species, odonate larvae live in the water for less than two months to more than five years. When the larva is mature it climbs out of the water, often onto a piece of emergent vegetation. In a dramatic metamorphosis, the larval exoskeleton splits open along the head and the top of the thorax and the adult dragonfly emerges from its larval skin. Once emerged, the adult rests while its wings dry and expand. Then it takes flight for the first time, leaving behind the larval skin or exuvia. After emerging, the adults usually spend a period of days or weeks resting, hunting and gaining weight in upland habitat, before returning to the water to breed. During their time away from the water, adults become sexually mature and their colours change, often becoming brighter and more striking.

Like the larvae, adult odonates are voracious predators, preying on flying insects including mosquitoes, midges and even other odonates. Their success as predators is due to their acute vision and their speed and manoeuvrability in the air. Odonates are extremely well adapted to flying and can catch prey, eat, mate and lay eggs while in flight. Large dragonflies have been reported to reach speeds in excess of 50 km per hour! The adult stage is typically the shortest stage of the life cycle, usually lasting only a few weeks. No odonates over-winter as adults in Canada, but at least two species are migratory.

Odonates breed in a wide variety of aquatic habitats. Their distribution is dependent on a number of factors including acidity of the water, water flow, vegetation, substrate type, competition from other organisms, predation, disturbance and pollution levels. Generalist species, which are able to survive in a variety of habitats, tend to be widely distributed. Specialist species that have specific habitat requirements (such as the Pygmy Clubtail (*Ophiogomphus howei*), a species of clear, fast-flowing streams) tend to have sparser, more localized distributions. This can make specialist species vulnerable to population declines as a result of habitat disturbance and destruction.

The odonates are a fascinating group of insects that has been attracting increasing attention in recent years from both professionals and amateurs, including children, as demonstrated by the increasing number of scientific and popular publications devoted to odonates. Odonates are both beautiful and interesting to observe with their complex behaviours and striking colours. There is even a colourful diversity in the intriguing common names of odonates, such as River Jewelwing (*Calopteryx aequabilis*), Umber Shadowdragon (*Neurocordulia obsoleta*) and Slaty Skimmer (*Libellula incesta*). Because odonates are predatory and voracious, and are in turn, important prey items for fish and birds, they play an important role in the ecosystems in which they live. Some species of odonates are sensitive to water quality, potentially making them important environmental indicators.

Status of knowledge

The odonates are one of our best-known insect groups, but the life history, distribution and habitat requirements of many species of Canadian odonates are poorly understood. Without this basic knowledge, it will be difficult to determine population trends or to prevent population declines or extinctions.

Over the past decade, odonate surveys have improved the knowledge of odonate habitat and distribution in a number of provinces and territories. For example, prior to 1995, the Quebec Emerald (*Somatochlora brevicincta*) was known only from a few isolated peatlands in Quebec, but has now been found in New Brunswick, Nova Scotia, Newfoundland and Labrador, and British Columbia. This is probably not a recent range expansion; rather, new surveys and a better understanding of its ecology have led to its discovery in new locations. Similarly, recent surveys in the Northwest Territories added five species of odonates to the territorial species list.

In the future, systematic surveys, long-term monitoring and focused research projects into biology, life history, threats and other relevant questions will be necessary to improve knowledge of Canadian odonates. This will be particularly important in the north, where odonates are poorly known. Ongoing volunteer projects, such as the Ontario Odonata Survey and Atlas and the Manitoba Dragonfly Survey will be important in providing long-term information on the distribution and biology of odonates. The results of this general status assessment have aided the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in prioritising odonate species for detailed COSEWIC status assessments, which will examine the status of some species currently ranked as May Be At Risk in greater details.

Richness and diversity in Canada

Within Canada, odonate species richness is highest in the eastern provinces, from Nova Scotia to Ontario (figure 11), particularly in Ontario, where 172 of Canada's 211 species of odonates can be found, including a new breeding species since the last assessment. Although species richness is lower in the north than in southern Canada, the abundant, pristine wetlands of the north provide widespread and varied habitats for northern species, such as the Treeline Emerald (*Somatochlora sahlbergi*), which is found only in the Yukon and Northwest Territories in Canada. All the odonates known from Canada have also been found in other countries.

Species spotlight - Broadtailed Shadowdragon

Scientists are well aware that the earth's species have not all been discovered or named, but in 1993 a Canadian field biologist reduced the number of species left to be discovered by one. On the Canoose Stream in southwest New Brunswick, Paul-Michael Brunelle came across an exuvia that he couldn't identify. Exuviae are left behind when a larva metamorphoses into an adult odonate and are useful in identifying odonates. Despite the involvement of several experts, the species still could not be identified. The next year, adult males and females of an unknown species were found in the same location, further deepening the mystery. Finally, in 1996, the unknown adults were seen emerging from the unknown exuviae and it was confirmed that both were of the same, new, species, later named Broadtailed Shadowdragon (*Neurocordulia michaeli*). An easily overlooked species that flies only at dusk, the Broadtailed Shadowdragon has since been found in Maine, and Ontario. Broadtailed Shadowdragon has now a Canada General Status Rank (Canada rank) of Secure.

The opportunity to make new discoveries, such as this, is one aspect that attracts enthusiasts to the study of odonates. New county records of odonates are regularly reported, and new provincial and territorial records are not unusual, but the discovery of a new species is a thrill few people can hope to experience in their lifetime.

Species spotlight - River Jewelwing

Reaching lengths of over 5 cm, the River Jewelwing (*Calopteryx aequabilis*) is one of Canada's largest damselflies, and also one of the most spectacular. The River Jewelwing (Canada rank: Secure) is found in all the provinces and in the Northwest Territories. Commonly found along the shores of rivers and large creeks, this damselfly has a beautiful, butterfly-like flight.

Female River Jewelwings lay their eggs in the stems of submerged aquatic vegetation, 30 cm or more below the surface of the water; females can remain submerged for half an hour or more, while laying their eggs! Once hatched, the larvae spend at least two years in the water, before metamorphosing into adults. Adult River Jewelwings are distinguished by their spectacular metallic green bodies and their broad wings, which appear as if the outer half has been dipped in black ink. Adult females spend much of their time foraging in upland habitat and only return to the water to mate and lay eggs. Males however, spend most of their time defending their territories along the banks of rivers and large creeks. Once a female enters a male's territory, the male initiates an elaborate courtship dance. First, the male conducts a display flight over a potential egg-laying site in his territory. The flight displays the handsome markings on the hind wings and this may assure the female that he is of the correct species and a suitable mate. Next the male hovers in front of the female, until she allows him to mate. Finally, the female lays her eggs and the life cycle begins again.

The combination of being easy to observe and manipulate, together with a wide distribution and complex behaviour patterns, make these damselflies an excellent study species for a range of behavioural and ecological questions. River Jewelwings have taught scientists much about damselfly movement through upland habitat, courtship behaviour, and species discrimination during courtship. For both amateurs and professionals, these beautiful damselflies are endlessly fascinating to observe.

Results of general status assessment

The report *Wild Species* 2010 marks the second national assessment for odonates. The rankings for odonates were finished in November 2009 and reflect data available up to that time. The majority of Canada's 211 odonates have Canada ranks of Secure (155 species, 74%, figure 11 and table 15). Twenty species have Canada ranks of Sensitive (9%), 22 species have Canada ranks of May Be At Risk (10%) and one species, the Rapids Clubtail (*Gomphus* *quadricolor*) is At Risk based on a COSEWIC assessment in 2008 of Endangered. This was the first year that COSEWIC assessed odonates.

Eleven species of odonates have Canada ranks of Undetermined (5%), but this proportion is much higher in some provinces and territories, reflecting a need for increased survey effort. Finally, two species have Canada ranks of Accidental (1%).

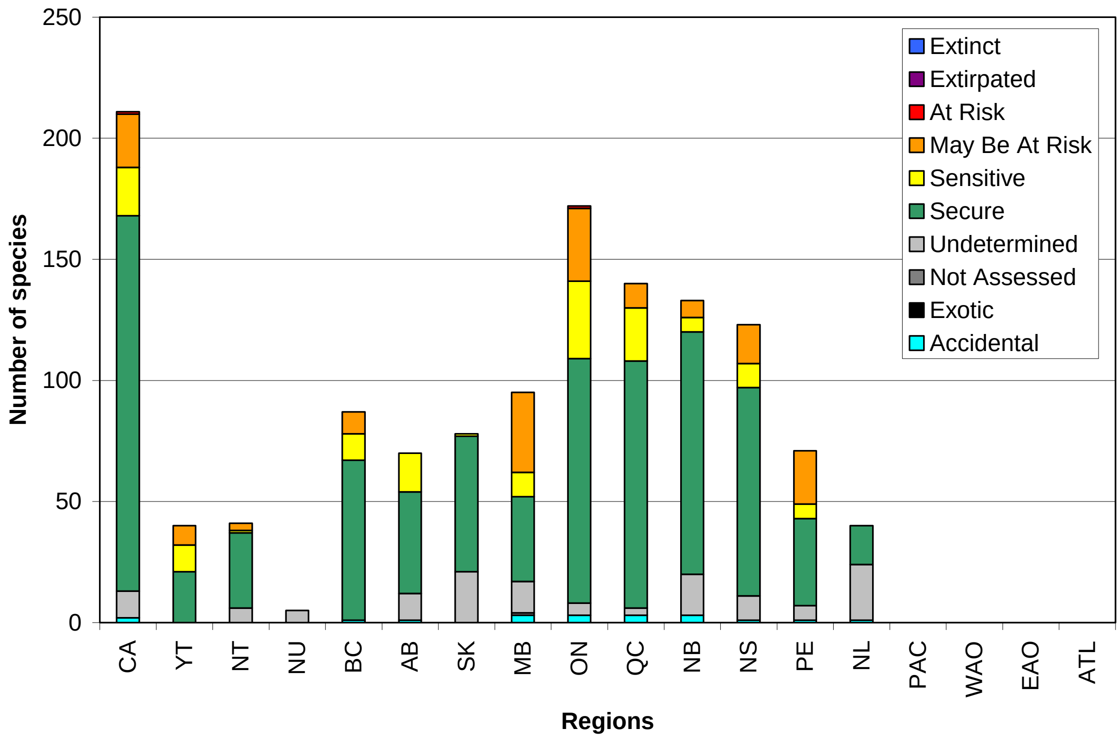

Figure 11. Results of the general status assessments for odonate species in Canada in the *Wild Species* 2010 report.

Comparison with previous Wild Species reports

In general, the 2010 assessment resulted in fewer species that were identified as May Be At Risk or Sensitive and an increase in the number of species ranked as Secure (table 15). A total of 25 species had a change in their Canada rank since the last assessment. Among these changes, one species had an increased level of risk, 14 species had a reduced level of risk, six species were changed from or to the rank Undetermined, three species were added and one species was deleted. In most cases, this is not an indication of a biological change, but of an increase in survey effort (table 16). The accuracy of the assessments has increased with the greater survey effort, meaning that the remaining species with some category of risk assigned will be more likely to be at risk and will be more likely to require some attention.

Table 15. Changes in the number of odonate species over time in each rank category as determined by the National General Status Working Group.

	Canada rank	Years of the *Wild Species* reports			Average change between reports	Total change since first report
		2000	2005	2010		
0	Extinct / Extirpated	-	0 (0%)	0 (0%)	-	Stable
1	At Risk	-	0 (0%)	1 (1%)	-	+1 species
2	May Be At Risk	-	28 (13%)	22 (10%)	-	-6 species
3	Sensitive	-	27 (13%)	20 (9%)	-	-7 species
4	Secure	-	145 (70%)	155 (74%)	-	+10 species
5	Undetermined	-	7 (3%)	11 (5%)	-	+4 species
6	Not Assessed	-	0 (0%)	0 (0%)	-	Stable
7	Exotic	-	0 (0%)	0 (0%)	-	Stable
8	Accidental	-	2 (1%)	2 (1%)	-	Stable
	TOTAL	-	209 (100%)	211 (100%)	-	+2 species

Table 16. Reasons for changes in the status of odonate species between the last assessment and the current report.

Scientific name	English name	2005 Canada rank	2010 Canada rank	Reason for change
Archilestes grandis	Great Spreadwing	5	2	(I) Improved knowledge of the species; it is now known to breed in Ontario.
Agrigomphus villosipes	Unicorn Clubtail	2	3	(I) Surveys over the past few years have resulted in additional locations for the species.
Celithemis eponina	Halloween Pennant	3	4	(I) Survey work over the past few years has increased the number of known sites for this species.
Celithemis martha	Martha's Pennant	5	4	(I) Improved knowledge of the species.
Enallagma anna	River Bluet	3	5	(P) Change due to procedural changes.
Enallagma minusculum	Little Bluet	3	4	(I) Improved knowledge of the species.
Erythrodiplax berenice	Seaside Dragonlet	2	3	(I) Improved knowledge of the species.
Gomphaeschna furcillata	Harlequin Darner	2	3	(I) Survey work over the past few years has increased the number of known sites.
Gomphus abbreviatus	Spine-crowned Clubtail	2	4	(I) There have been additional surveys and new records for this species.
Gomphus quadricolor	Rapids Clubtail	2	1	(C) This species is now listed by COSEWIC as Endangered.

Ischnura damula	Plains Forktail	3	4	(I) Considered Secure after extensive surveys.
Ischnura hastata	Citrine Forktail	2	5	(B) It now appears as if this species is an irregular breeding immigrant to Ontario.
Lanthus vernalis	Southern Pygmy Clubtail	-	5	(I) New species, known from one locality in NB.
Lestes australis	Southern Spreadwing	-	5	(T) This taxon was recently elevated to the species level.
Lestes vigilax	Swamp Spreadwing	3	4	(I) Survey work over the past few years has increased the number of known sites for this species.
Neurocordulia michaeli	Broadtailed Shadowdragon	3	4	(I) New records over an increased range.
Neurocordulia obsoleta	Umber Shadowdragon	2	5	(E) Previous record based on misidentification; still believed to occur, but status is unknown.
Ophiogomphus anomalus	Extra-striped Snaketail	3	4	(I) Increased survey effort has found this species in more locations.
Perithemis tenera	Eastern Amberwing	3	4	(I) Survey work over the past few years has increased the number of known sites for this species.
Somatochlora brevicincta	Quebec Emerald	3	5	(P) Change due to procedural changes.
Somatochlora ensigera	Plains Emerald	2	3	(I) Ranked as Sensitive after extensive surveys.
Somatochlora hineana	Hines' Emerald	-	2	(I) This species was discovered new to Ontario and Canada in 2007.
Somatochlora tenebrosa	Clamp-tipped Emerald	3	4	(I) Improved knowledge of the species.

Sympetrum occidentale	Western Meadowhawk	4	-	(T) Now considered to be part of *Sympetrum semicinctum*.
Williamsonia fletcheri	Ebony Boghaunter	3	4	(I) Improved knowledge of the species; ranked as secure in New Brunswick.

Threats to Canadian odonates

In order to successfully complete their life cycle, odonates require both aquatic and terrestrial habitats, and are therefore potentially vulnerable to habitat degradation and destruction both on land and in the water. In aquatic systems, destruction and degradation of wetlands, damming and channelling of rivers and streams, and water pollution can all negatively impact odonate populations. Recreational use of waterways can reduce the abundance and diversity of odonates, since boat wakes can kill individuals during the vulnerable emergence period. Odonates are also vulnerable to ecosystem changes resulting from invasion of exotic species. Modifications to land adjacent to aquatic habitat can affect odonates directly, by degrading the upland habitat they use to mature and hunt, and indirectly by affecting water quality.

Conclusion

This general status assessment shows that although almost three-quarters of Canada's odonates have a Canada rank of Secure, 10% are ranked May Be At Risk. Odonates and insects generally have not received as much attention from biologists and conservationists as well-studied groups, like birds and mammals – but it is increasing, particularly for the odonates. This general status assessment was made possible by the cooperative contributions of both amateur and professional field biologists, and has aided COSEWIC in selecting a number of priority species for detailed status assessments. Detailed COSEWIC assessments will consolidate our knowledge of species ranked as May Be At Risk, while amateur and professional field biologists across the country will continue to improve our knowledge of the life history and distribution of odonates in Canada. The vast area of Canada where no one has ever looked for odonates makes the discovery of a new species a thrilling possibility!

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Predaceous diving beetles

Dytiscidae - Family of insects in the order Coleoptera. These species are mostly black, dark brown, or dark green, but some have golden and other highlights. They have sharp and short jaws for biting their prey. Most are about 25 mm long but some can grow up to 45 mm long. The larvae are commonly known as water tigers.

Quick facts

- Canada has at least 275 of the 500 species of predaceous diving beetles known from North America and roughly 4000 species known world-wide. Predaceous diving beetles are distributed over most of the world.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the great majority (98%) of predaceous diving beetles in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 1% have Canada ranks of Sensitive and 1% have Canada ranks of May Be At Risk. However, it should be noted that many of the predaceous diving beetle species were ranked as Undetermined.

- The family name *Dytiscidae* (from the genus *Dytiscus*) is reportedly derived from the Greek word *dytikos* meaning “able to dive”.

- Eggs are laid inside aquatic plant tissue and hatch in about three weeks. Once the larvae grow, they move to the water’s edge, burrow into the soil and pupate.

- The larvae, commonly known as water tigers, are effective and active predators, but some adults may also scavenge dead prey, eat their own species, or even eat plants.

- Larvae are quite terrifying in appearance, with elongate bodies with a round flat head. They seize their prey with their strong jaws, inject it with powerful digestive enzymes and then suck in the liquefied internal parts.

- Water surface tension can be quite a barrier for diving beetles wanting to leave the water to fly to other locations. Ingested water expelled rapidly through the rectum can help smaller beetles push through this barrier and become air born.

Hygrotus sayi © Tom Murray

Background

Like all water beetles, predaceous diving beetles are air-breathing terrestrial insects that have evolved body features that allow them to live in the water. Larvae and adults are aquatic but they have to go to the surface to obtain air. Adults exchange and store fresh air under their wing coverts, or elytra, while larvae store air within their bodies. Diving beetles control or maintain their buoyancy in the water by controlling the size of the air pocket under their wings. This works well when they are eating well and have a full digestive system. When their stomach and abdomen is empty, they have to ingest water to prevent them from continuously floating to the surface. Adults swim by sculling or rowing with modified hind legs, but not all of these beetles are strong swimmers. Some less stream-lined types live in dense underwater vegetation, in gravel or under rocks. Like loons and other aquatic birds with legs modified for swimming, many predaceous diving beetles also walk awkwardly on land.

These beetles feed on a wide range of smaller invertebrates but some larger species can also eat amphibians, fish, and even reptiles. In turn, they can be abundant in some areas and serve an important food source for fish and aquatic and shore birds.

The larvae of some species are relatively dense-bodied and poor swimmers and live on the bottom, creeping over vegetation or burrowing in the mud. Others are buoyant and float or live on near the water surface when not actively swimming using all their legs. Larvae can flex their abdomens rapidly to move quickly over short distances to escape predators.

All but two Canadian species of diving beetles appear to be able to fly as adults. These beetles fly to populate new habitat, find suitable overwintering areas, or to avoid aquatic environments that are changing or drying up. Water beetles fly both during the day and at night, and are sometimes attracted to the shiny surfaces of cars, plastic or wet pavement which may look like water to them. For many Canadians, their first face to face encounter with a predacious diving beetle is in their backyard swimming or wading pool.

The life cycle of species in Canada are largely influenced by the freezing of aquatic habitats and spring snow melt, but season rain patterns do control how species behave in southern warm and arid ecosystems. Different kinds of predaceous diving beetles overwinter either as eggs, larvae, or adults.

Status of knowledge

All Canadian species of predaceous diving beetles are herein assessed for the first time in the *Wild Species* series. On a cautionary note, scientific diving beetle experts report that while most North American species are well described, some are difficult to identify and more research is needed before a stable and reliable classification system is obtained. Much remains to be learned about their basic life history or basic biology, offering Canadians from all walks of life an opportunity to make a significant contribution to our knowledge of these remarkable creatures.

Richness and diversity in Canada

In many groups of plants or animals there is an increase in species diversity in lower latitudes, but this does not seem to hold true for predacious diving beetles in Canada – our dytiscid fauna is about as diverse as other regions in the world based on the same area. One suggestion for this anomaly is that their ability to disperse by flight aided the relatively rapid recolonization of

Canada's diverse post-glacial aquatic habitats. One Alberta boreal pond was found to support up to 50 species!

Canada's 275 species are classified into six subfamilies and 35 genera. The largest genera include *Agabus* (66 species), *Hydroporus* (41 species) and *Hygrotus* (29 species). Predacious diving beetles can be found in all provinces and territories in Canada.

Species spotlight - Hydroporus carri

This small (4 mm) uncommon Alberta species is found in springs. It is black to dark brown but sports a small reddish spot above each antenna. This species is found in small springs and seepages in foothill and subalpine areas in prime ranching country where its habitat is susceptible to damage from livestock. Considered at risk in much of its range (Alberta, Idaho, Utah and Oregon) it has been ranked by the General Status assessment process as May Be At Risk in Alberta and Canada. Conservation measures such as managing livestock access to water and its ability to colonize suitable habitat suggests that humans can create opportunities to conserve this species.

Species spotlight - Dytiscus dauricus

This large (up to 40 mm) black diving beetle has a greenish reflective upper surface and a reddish-yellow underside. Its antennae are yellow at the base and its legs are mainly yellow to reddish. It is widely distributed in Canada and across about one-half of the USA. It is also found in northern Eurasia. It is found in permanent ponds in forested areas from sea level in the north and at higher elevations in the south. In Arizona, it is known to feed on larval salamanders. The General Status rank of Secure was assigned to this species based on its readily available and abundant habitat and its wide distribution in Canada.

Species spotlight - Graphoderus manitobensis

This medium-sized (13-15 mm) diving beetle was first described by Wallis in 1933 from a specimen collected in Winnipeg, Manitoba (known as the "Type Locality"). It has elsewhere only been collected thus far in some localities in southern Wisconsin. It occurs in large sedge and cattail marshes and ponds in open areas. It was assessed with a general status rank of Undetermined because there is insufficient information about its range and relative abundance in Manitoba and Canada. It is distinguished from a similar species, *Graphoderus fascicollis*, by the unique shape of a front claw and by the male's genitals. Additional search efforts should enable a better assessment of its general status in 2015.

Species spotlight - Agabus immaturus

This small (7.6 -7.9 mm) dark red headed and legged diving beetle is known only from one location in Canada; a sedge marsh in Tabusintac, New Brunswick. In the United States it is similarly limited in distribution to a few locations in Michigan and Wisconsin. The general status rank of Undetermined was assigned to this and many other diving beetles, highlighting the extent of our ignorance of the basic criteria or information needed to assign more definitive conservation status ranks.

Results of general status assessment

Most predaceous diving beetles have a Canada general status rank of Secure (75%). However, 23% of the species are not well known enough and are ranked as Undetermined. Finally, three species are considered Sensitive and two species are considered as May Be At Risk (figure 12 and table 17). Because of a general lack of information in many regions, the assessement of the predaceous diving beetles included in the *Wild Species* 2010 report is likely to change in the future reports of the series with a potential improved knowledge on these species.

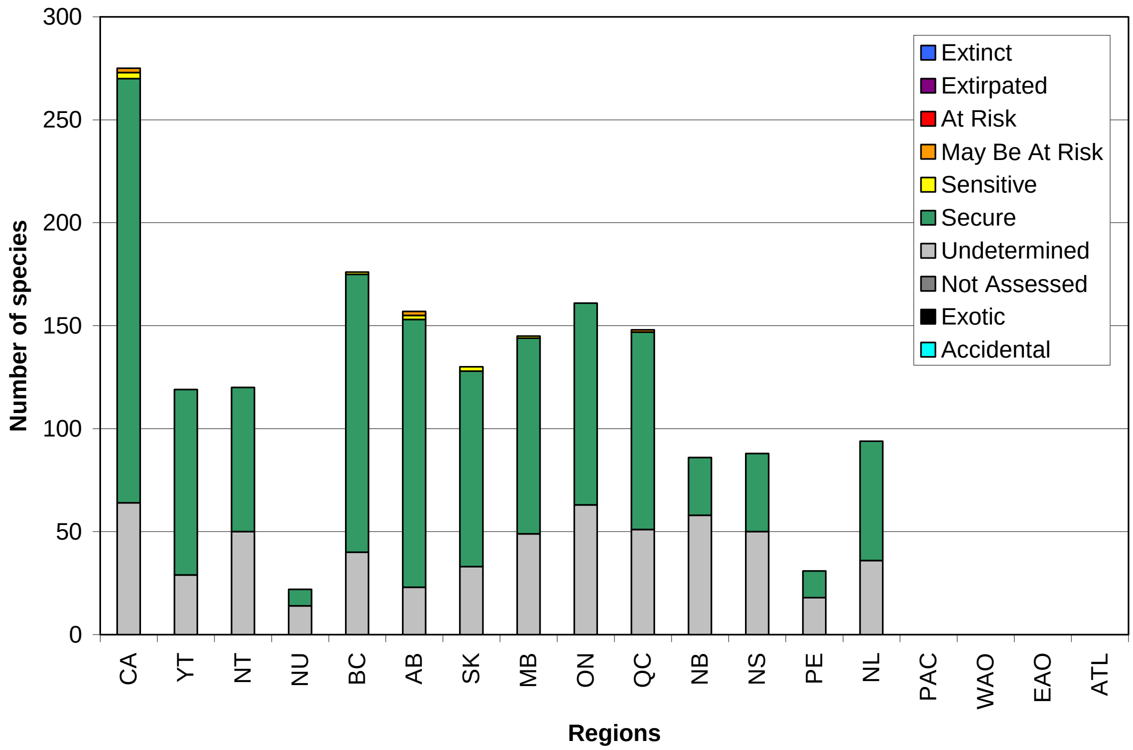

Figure 12. Results of the general status assessments for predaceous diving beetle species in Canada in the *Wild Species* 2010 report.

Table 17. Canada ranks of predaceous diving beetle species as determined by the National General Status Working Group.

	Canada rank	Number and percentage of species in each rank category
0.2	Extinct	0 (0%)
0.1	Extirpated	0 (0%)
1	At Risk	0 (0%)
2	May Be At Risk	2 (1%)
3	Sensitive	3 (1%)
4	Secure	206 (75%)
5	Undetermined	64 (23%)
6	Not Assessed	0 (0%)
7	Exotic	0 (0%)
8	Accidental	0 (0%)
	TOTAL	275 (100%)

Threats to Canadian predaceous diving beetles

Predaceous diving beetles have not been commonly used as indicators of local environmental degradation in North America because of a lack of species-specific studies on the tolerance of each species along environmental gradients. Likewise, the concern about the conservation of water beetles and their habitats is not common or widespread. The drainage of wetlands is known to reduce their abundance and diversity, and chemical pollution and the use of insecticides negatively affects populations. But people also create habitat for these beetles by creating water bodies – many of them are adapted to unstable habitats and environments. Those species with a limited distribution and that are habitat specialists are at the greatest risk. For example, see the species spotlight for *Hydroporus carri*. It is these species that need sound habitat management or protected areas to ensure their continued survival from human activities that alter these habitats.

Conclusion

Most studies on predaceous diving beetles have been on documenting where they occur, and the time of year when adults are found. Some studies have described beetle community diversity and habitat associations. More research is needed on their population status and trends, basic natural history, environmental tolerances, and especially about their life as larvae.

Further information

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Ground beetles

Carabidae - Family of insects in the Coleoptera order. These species are generally dark-coloured, long-legged, predatory beetles with thread-like antennae. Tiger beetles (Cicindelidae) represent a sub-family of the ground beetles.

Quick facts

- There are more than 30 000 species of ground beetles in the world, of which 934 have been found in Canada.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (88%) of ground beetles in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 6% have Canada ranks of Sensitive and 6% have Canada ranks of May Be At Risk. However, it should be noted that the many of the ground beetle species were ranked as Undetermined.

- Three species are ranked as At Risk following a detailed COSEWIC assessment. They all are tiger beetle species.

- A total of 54 Exotic species were found among the ground beetles in Canada.

- Ground beetles are aptly named as most are found at the surface of the soil. However, a few Canadian species are usually found running on herbaceous plants and even on trees.

- Ground beetles are active, usually fast-running predators that vary in size from tiny (1.4 mm) to impressively large (30 mm). The Bronzed Tiger Beetle (*Cicindela repanda*) can run at speeds up to 0.5 meters per second; taking body size into account, that is 10 times faster than the fastest human sprinters!

Cobblestone Tiger Beetle, *Cicindela marginipennis* © Henri Goulet

Background

All species of ground beetles are assessed for the first time in the *Wild Species* series. However, the tiger beetles (*Cicindelidae*) were first assessed by the National General Status Working Group in the *Wild Species* 2005 report. Since most authorities now classify tiger beetles as belonging to the ground beetle family (*Carabidae*), we have included the reassessment of the tiger beetles in the ground beetles section of the *Wild Species* 2010 report.

Ground beetles are commonly seen from the spring melt of snow until the first snows of winter. Individuals can easily be found under leaves and rocks in the middle of winter after removing the snow cover. Adult ground beetles are a little difficult to characterize in a few words. They have long legs and are excellent runners. They also generally have rather long, thread-like antennae. Few ground-dwelling beetles in other families show these features. Some darkling beetles (*Tenebrionidae*) look like ground beetles, but their hind legs have only four tarsal segments, whereas ground beetles have five segments. Darkling beetles are common in dry regions, but otherwise are uncommon in Canada. Except for tiger beetles, most ground beetles have a clear pattern of long furrows in their wing covers (elytra). Adults vary greatly in size (from 1.4 to 30 mm) and in colour patterns, though most are black or brown. Because they don't generally fly and can be found hiding under objects during the day, these beetles are one of the easiest insect groups to find even under very inclement weather conditions.

Most ground beetles are fast-running species. For example, adult tiger beetles are voracious predators, locating prey by sight and giving chase across the ground at astonishing speeds of up to 53 body lengths per second (about 10 times faster than a top human sprinter!). But rather than chasing prey continuously, tiger beetles often pause momentarily during the chase before continuing at full speed once more. Scientists now believe they know the reason for this stop-start method of pursuit. At the high speeds that tiger beetles achieve while chasing their prey, light cannot enter the eye fast enough to form an image of the moving prey item; at high speeds the tiger beetle goes temporarily blind! Pausing during the pursuit allows the tiger beetle to relocate its prey, while its incredible speed still allows it to complete the chase successfully.

Ground beetles are generally known as predators, but the reality is a little more complex – the food range is quite wide. Most predators are opportunistic as they also commonly scavenge dead insects and drink from mature fruits. Most predators are generalists, but in a few groups they specialize in certain types of prey. For instance, species in the genus *Calosoma* feed exclusively on caterpillars (hence their common name, caterpillar hunter) and those of *Scaphinotus* hunt only snails and slugs (hence the name snail beetles). The herbivores fall basically into two groups: the seed collectors (various species of *Harpalus*) and the plant tissue feeders (various species of *Amara*). In addition, many plant-dwelling species are commonly seen feeding on flower nectar. The plant dwellers may be predatory but flower nectar, like mature fruits, may be very attractive. Larvae follow generally a similar pattern as described above, but species of *Brachynus* (bombardier beetles) are external parasites ("parasitoids" is a better term as the larva kills its host) of whirligig beetle (*Gyrinidae*) pupae, and those of *Lebia* are external parasites of leaf beetle (*Chrysomelidae*) pupae. Ground beetles are mainly active at night. However, there are exceptions in such a large family – many species (for example, some in *Bembidion* and *Amara*) are diurnal.

Ground beetles go through four developmental stages in their life cycle; egg, larva, pupa and adult. Eggs are laid singly in carefully chosen soils or even under bark of trees, where the moisture and humidity will provide the proper environment. Newly-hatched larvae move away from the egg shell and soon look for food. Larvae of predatory species have very long and very sharp, needle-like mandibles. Anything of proper size that moves is potential food, including their siblings. Dispersing soon after hatching is crucial for these larvae! All Canadian species that have been studied go through three larval stages, or instars. The development of spring-breeding species is fast and is completed within one month from the time the eggs have been laid, whereas that of the summer breeding species is much longer as they must overwinter before completing their development. At the end of the third larval instar, the larva stops feeding, becomes lethargic, and usually builds a cell in the soil. This is the prepupal stage. When ready, the prepupa molts again and a white pupa emerges and remains on its back. Pupal development is usually fast and soon the new adult emerges from the pupa with a pale, soft cuticle. In a few days the cuticle hardens and darkens. Among the spring-breeding species, adults may remain within the pupal cell until the following spring, or may run for a few weeks in the early fall without breeding. Among the summer-breeding species, the new adults immediately run out to feed and look for mates.

Adults of all species are found over a long period of two to six months. Larvae of spring-breeding species complete their cycle within one month, while adults commonly live two to five years. Larvae of summer-breeding species usually take one year to complete their development and overwinter before transforming, and adults of most of these species do not live beyond one breeding season. Adults commonly winter under rocks and other moderate-sized debris, under leaves and under bark of dead trees, or deep in the soil (species of *Calosoma* and *Chlaenius*). In Canada, overwintering is a special and necessary inactive stage for most ground beetles. This stage is called a diapause. Adults of most spring-breeding species need to go through diapause before they will start breeding. The overwintering larvae of summer-breeding species need to go through diapause in order to continue development. The warming trend in the spring causes the end of the diapause period.

Status of knowledge

Relative to most insect groups, ground beetles are well understood and most species are known and described. The Canadian list is relatively stable, although new species are occasionally discovered and classifications are occasionally changed. Many amateurs and scientists have built large reference collections of this very diverse group across Canada. The most significant reason, however, is the extraordinary work initiated by C. H. Lindroth (1961 to 1969), who published on the complete fauna of ground beetles of Canada and Alaska. George Ball and his students at the University of Alberta also added many significant revisions to complete Lindroth’s work. But even forty years after Lindroth’s publications, there are surprisingly few changes to his concepts. Other studies, such as the numerous publications of André Larochelle (for example: Larochelle and Larivière, 2003) and more recently the book of Bousquet (2010), also represent important works. But are there places for new discoveries? The answer is an emphatic “Yes.” The study of ground beetles of Canada is now on another level of understanding. The undiscovered species are cryptic, requiring careful observations and studies to be recognized. The first clue is in nature, because most species of ground beetles have special life cycle and habitat requirements, but more recently the use of new genetic methods of investigation have uncovered previously unknown species.

Despite the relatively good understanding of which species live in Canada and how to recognize them, there is much to be discovered about the details of their biology. Here, our knowledge is only basic. By analogy, we have the dictionary of Canadian ground beetles, but now there is a need to explore beyond definitions. We need to explore the details of their biology and the interactions with other species in various ecosystems. Adults have been used often as biological indicators in various habitats. As indicator species, we know that each species is sensitive to habitat disturbances and modifications, to the use of pesticides, and to introduced species. All these factors strikingly affect the species composition of ecosystem.

Richness and diversity in Canada

Canada’s 934 species are classified into 126 genera. The largest genera are *Bembidion* (174 species), *Pterostichus*, *Agonum*, *Amara*, and *Harpalus*. Ground beetles are found in all provinces and territories, as far north as Devon Island (*Amara alpina*). Moving southward, diversity increases near tree line and species number increases rapidly in the cold temperate zone, and reaches the maximum in southernmost Ontario and southwestern British Columbia. Unfortunately, these last two regions are the two most affected by human activities.

Species spotlight - Vietinghoff’s Ground Beetle

A preconception about northern insects is that they are small, black and probably all related to mosquitoes. Vietinghoff’s Ground Beetle (*Carabus vietinghoffi*) is probably one of the most elegantly coloured species of ground beetle in Canada, and is also one of the largest. This species is found in both Asia and North America, with its distribution centered on the Bering Sea. In Canada, it is recorded from western Nunavut (Kugluktut), Yukon and Alaska, from just north of tree line south into the central portions of the boreal forest. The southernmost record is from the banks of the Pelly River, Yukon, about 150 kilometres north of Whitehorse. The females are spring breeders and seem associated with moderately drained sites with trees or bushes. This species has a general status Canada rank of Secure.

Species spotlight - Poecilus lucublandus

This quite elegant species, which has no official common name, is coloured yellow green on the head and the pronotum and purple on the wing covers, all set off with metallic reflections. It is found across Canada from central boreal regions southward. In spring, it is a typical insect of gardens and lawns – adults like moderately moist soil. Adults breed in the spring, larval development takes place in summer and new adults run in early fall but do not breed. Adults overwinter under debris and rocks. Adults and larvae are nocturnal predators; they probably consume fly larvae and other soft-bodied invertebrates in the soil. In day, adults are found easily under rocks and wood pieces. When disturbed during the day, they run very rapidly to a dark spot or a small hole or crack in the soil. Because of their association with human habitats, they are often found in agricultural sites.

Species spotlight - Ghost Tiger Beetle

The Ghost Tiger Beetle (*Cicindela lepida*) is a small tiger beetle found on undisturbed white sand in coastal and lake-shore sand dunes, as well as inland sand dunes and sand flats. Within Canada, the Ghost Tiger Beetle is found in the prairie provinces and in Ontario and Quebec. Ghost Tiger Beetles are pale in colour, with faint brownish markings on the elytra, making it difficult to see against the sand. When predators approach, the Ghost Tiger Beetle freezes against the sand and relies on its camouflage to protect it from detection. In fact, its camouflage is so good, that the beetle's shadow is often easier to see than the beetle itself, leading to its unusual name. The life history of the Ghost Tiger Beetle has been described as unique among tiger beetles because the larvae live for two years, over-wintering twice, while the adults only live for about one month!

Although the Ghost Tiger Beetle can form large populations in suitable habitat and is thought to be able colonize new habitat fairly easily, local populations are vulnerable to habitat loss due to human development or to natural succession and to disturbance by heavy recreational use of their habitat. This species has a Canada General Status Rank (Canada rank) of Sensitive.

Results of general status assessment

A large portion of Canada's 934 assessed species of ground beetle have a Canada rank of Secure (545 species, 58%, figure 13 and table 18). However, 36 species (4%) have a Canada rank of May Be At Risk, and also 36 species (4%) have a Canada rank of Sensitive. Three species are ranked as At Risk following a detailed COSEWIC assessment; they all are tiger beetle species.

Finally, 260 ground beetle species (28%) have a Canada rank of Undetermined, and 54 species (6%) are ranked as Exotic in Canada.

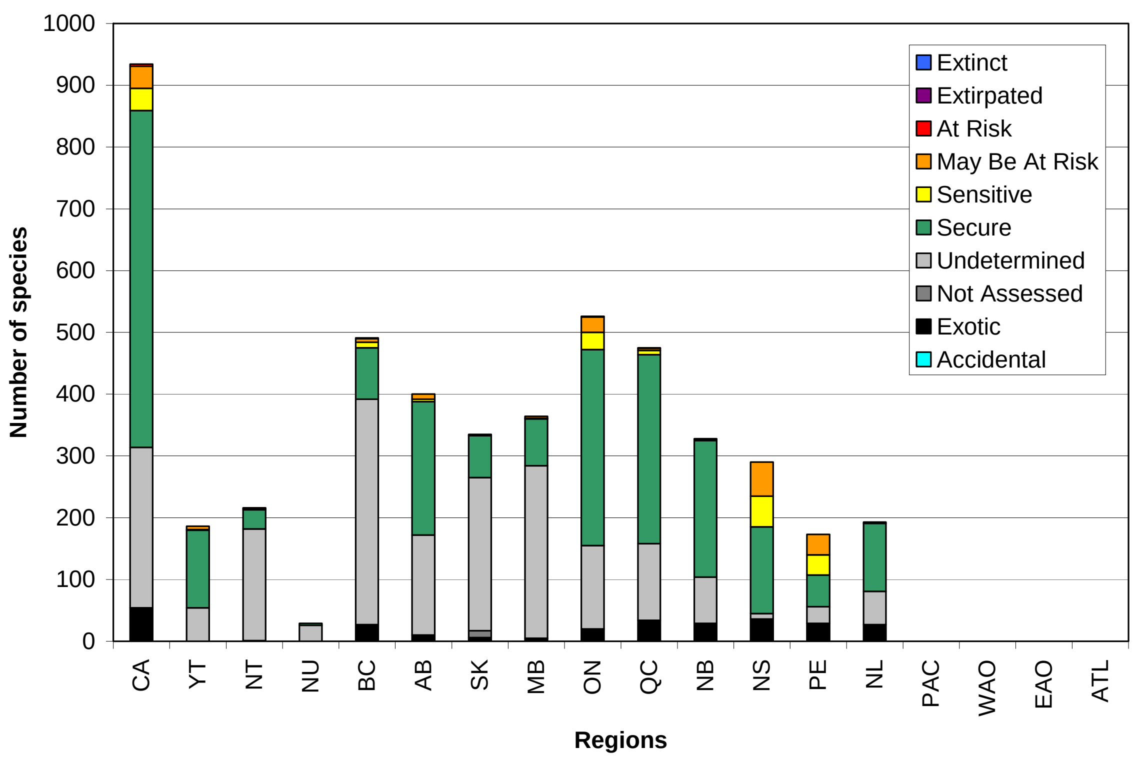

Figure 13. Results of the general status assessments for ground beetle species in Canada in the *Wild Species* 2010 report.

Table 18. Canada ranks of ground beetle species as determined by the National General Status Working Group.

	Canada rank	Number and percentage of species in each rank category
0.2	Extinct	0 (0%)
0.1	Extirpated	0 (0%)
1	At Risk	3 (0%)
2	May Be At Risk	36 (4%)
3	Sensitive	36 (4%)
4	Secure	545 (58%)
5	Undetermined	260 (28%)
6	Not Assessed	0 (0%)
7	Exotic	54 (6%)
8	Accidental	0 (0%)
	TOTAL	934 (100%)

Comparison with previous Wild Species reports

Since only the tiger beetles were assessed in a previous *Wild Species* report, the comparison will be made only for the 31 species of tiger beetles. Since 2005, the category of species ranked as At Risk had the highest increase in terms of number of species (table 19). All these species were previously in the category of May Be At Risk, and were changed following detailed COSEWIC assessments (table 20). A total of five species had a change in their Canada rank since the last assessment. Among these changes, three species had an increased level of risk and one species had a reduced level of risk. One species of tiger beetle was also added to the national list in 2010.

Table 19. Changes in the number of tiger beetle species (part of the ground beetles) over time in each rank category as determined by the National General Status Working Group.

	Canada rank	Years of the *Wild Species* reports			Average change between reports	Total change since first report
		2000	2005	2010		
0	Extinct / Extirpated	-	0 (0%)	0 (0%)	-	Stable
1	At Risk	-	0 (0%)	3 (10%)	-	+3 species
2	May Be At Risk	-	5 (17%)	2 (6%)	-	-3 species
3	Sensitive	-	3 (10%)	4 (13%)	-	+1 species
4	Secure	-	21 (70%)	21 (68%)	-	Stable
5	Undetermined	-	1 (3%)	1 (3%)	-	Stable
6	Not Assessed	-	0 (0%)	0 (0%)	-	Stable
7	Exotic	-	0 (0%)	0 (0%)	-	Stable
8	Accidental	-	0 (0%)	0 (0%)	-	Stable
	TOTAL	-	30 (100%)	31 (100%)	-	+1 species

Table 20. Reasons for changes in the status of tiger beetle species (part of the ground beetles) between the last assessment and the current report.

Scientific name	English name	2005 Canada rank	2010 Canada rank	Reason for change
Cicindela lepida	Ghost Tiger Beetle	2	3	(I) Improved knowledge of the species.
Cicindela marginata	Margined Tiger Beetle	-	2	(I) New species identified.
Cicindela marginipennis	Cobblestone Tiger Beetle	2	1	(C) COSEWIC assessed this species as Endangered in November 2008.
Cicindela parowana	Dark Saltflat Tiger Beetle	2	1	(C) COSEWIC assessed this species as Endangered in November 2009.
Cicindela patruela	Northern Barrens Tiger Beetle	2	1	(C) COSEWIC assessed this species as Endangered in November 2009.

Threats to Canadian ground beetles

Ground beetles, like other insects, are vulnerable to habitat loss and disturbance due to natural succession, changes in drainage patterns, erosion control and conversion of natural habitat for human uses. However, a more pressing concern in areas with large human populations is the use of pesticides. In Europe, it has been shown that all kinds of pesticides affect ground beetle populations negatively. In our region, insecticides are fast acting, but herbicides have a similar but slower impact on wild populations of numerous species associated with agricultural lands and lawns. Around Ottawa and Montreal over a period of one or two decades, many agricultural sites showed a marked population decrease; up to 60% of the species has been affected. Some common to very common day-active and spring-breeding species have not been captured in the past 25 years. Moreover, even in sites without pesticide use, the diversity of ground beetles clearly has been affected by herbicides from adjacent sites. The effect is such in these areas that the diversity of sites without history of pesticides is similar to that of sites with pesticides.

A new source of problems is associated with several species of alien earthworms in forest habitats in agricultural regions of Ontario and Quebec. Twenty to thirty species of ground beetles are normally expected in deciduous forests. In most sites, 100% of forest-inhabiting ground beetles are absent or near absent. However, two alien ground beetles, *Carabus nemoralis* and *Pterostichus melanarius* are abundant. Adults of the last two species feed on any earthworms (all are exotic in the region under study) while those of native forest species feed on fly larvae and probably other soft body insects. The original food of the native species was simply replaced by earthworms that compost the leaf litter within one year, with disastrous consequences that extend well beyond the ground beetles diversity.

Conclusion

Much remains to be learned about the biology and distribution of many ground beetle species. The status of ground beetles associated with southern agricultural regions (where the diversity was formerly the greatest) is of great concern. These beetles have been shown as important indicators of ecosystem health.

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Lady beetles

Coccinellidae - Family of insects in the order Coleoptera. These species are generally brightly coloured, often red with black markings, and they mostly feed on aphids.

Quick facts

- There are about 6000 species of lady beetles in the world, of which 166 have been found in Canada.
- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (84%) of lady beetles in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 16% have Canada ranks of Sensitive.
- Lady beetles belong to the family *Coccinellidae*, one subfamily, *Coccinellinae*, are the bright red and black species most people recognize. Most species are small black or brown beetles and rarely noticed.
- The bright red and black pattern of many species is a warning that they contain alkaloids and therefore taste bad to predators.
- Seven species of lady beetles are Exotic in Canada.
- Most lady beetles are predatory, feeding on aphids, hoppers, scale insects, mites and other soft-bodied plant feeders. Many of these are important in reducing populations of plant pests. A few species feed on moulds, pollen and plants.

Twice-stabbed Lady Beetle, *Chilocorus stigma* © Denis A. Doucet

Background

For insects, lady beetles (family *Coccinellidae*) have a very good reputation. The bright red and black species are readily recognized and perceived to be beneficial to humans and a popular subject for rhymes and song. Biocontrol programs often use lady beetles because adults and larvae of many species eat plant feeding insects, such as aphids and scale insects. Many are habitat generalists, congregating where aphids are plentiful, including gardens and agricultural fields where the bright colours make them easy to see. Once people realize that shape is more important than counting the number of spots, most species are relatively easy to identify. The widespread interest and ability to identify most species make them a good choice to be ranked as part of the general status program.

Most people recognize as lady beetles the ones that are relatively large (>5 mm), brightly coloured (red, yellow or orange) with black spots or stripes.

These are the ones most people think of when lady beetles (or Ladybugs or Ladybirds) are mentioned. About one third of the Canadian species fit this description. Bright colours are associated with bad taste. Most of the brightly coloured lady beetles have high concentrations of alkaloids that deter predators. The majority of species are more difficult to recognize as lady beetles, being smaller and usually lacking bright colours. They can be recognized by the rounded shape, head mostly hidden from above, clubbed antennae and a bilobed second tarsus.

In southern Canada, where most people live and see lady beetles, most of the individuals they see are of non-native species. Many attempts were made to introduce non-native lady beetles to assist with control of crop pests such as aphids. These introductions did not result in established populations. However unintentional introductions happened. Since the 1980s, non-native species are the ones that are most frequently seen in settled regions of southern Canada. The Seven-spotted Lady Beetle (*Coccinella septempunctata*) from Europe has been widespread since the 1980s. Since the mid-1990s, the Multi-coloured Asian Lady Beetle (*Harmonia axyridis*) has spread across southern Canada and now is the most abundant lady beetle in many locations. People notice this species more than other lady beetles because they congregate in buildings, including houses, barns and office buildings to spend the winter. It is also the species most often misidentified because of the variation in colour, from black to red to orange, and the variation in the number of spots, from none to more than 20. If only spots are counted, this species will usually be misidentified. More reliable is the relatively large size and the dark “M” on the section behind the head.

Coinciding with the arrival of non-native species, such as the Seven-spotted and Multi-coloured Asian Lady Beetles, has been the decline in populations of native species, such as the Nine-spotted Lady Beetle (*Coccinella novemnotata*) and the Transverse Lady Beetle (*Coccinella transversoguttata*). Both species were widespread in eastern Canada in a variety of habitats, including suburban and agricultural landscapes, up to the 1960s. The Nine-spotted Lady Beetle has not been seen in Ontario and Quebec since the 1980s and reports in western Canada have slowed to a trickle. The relative importance of factors such as competition with non-native species, disease, habitat change, and changes in agriculture are being studied.

Adult female lady beetles lay small clumps of eggs on plants where food will be available for the larvae. Larva often eats other eggs in the clump in which it was laid. If there are few aphids, this allows a larva to survive until aphid numbers can increase, or until the larva can walk to a nearby plant. Larvae are active predators of soft-bodied plant feeding insects (a few feed on moulds or plant leaves). They are elongate with three pairs of spindly legs near the head. After feeding for two to three weeks, they form a pupa, often on the plant where they were feeding. In the pupa, a radical transformation occurs, changing from the larva to the round adult with the hard wing covers that we are familiar with. A few days or weeks later, the adult emerges. Most species overwinter as adults, emerging in the spring to mate and lay eggs.

Status of knowledge

Due to their bright colours, association with habitats near human settlements and role in biocontrol of agricultural pests, some lady beetle species have been relatively well studied. Much of the work focuses on lady beetles as predators, their parasites, development and genetics. Almost all of the work has been done in agricultural systems. Little work has been done on habitat preferences away from agricultural landscapes and therefore geographic distributions and food preferences for species not found in agricultural systems are poorly known. Many species of lady beetles in natural ecosystems then remains relatively unknown.

Richness and diversity in Canada

A total of 166 of the approximately 475 species in North America are known from Canada. Fifty six of the Canadian lady beetles belong to the subfamily *Coccinellinae*, which are colourful beetles that are active during the day and common in human disturbed habitats. About 100 species of small, round, brown *Scymninae* make it the most diverse subfamily. Four other subfamilies are represented by one to eight species, *Sticholotidinae*, *Chilcorinae*, *Coccidulinae* and *Epilachninae*.

Lady beetles are found in every province and territory (figure 14). They are most diverse in British Columbia, Alberta, Ontario and Quebec with more than 70 species in each of these provinces.

Species spotlight - Seven-spotted Lady Beetle

The Seven-spotted Lady Beetle (*Coccinella septempunctata*) is the familiar red lady beetle with black spots found in most of southern Canada. Wherever aphids are abundant, there are bound to be some seven-spots. However 50 years ago, it did not exist in Canada.

The role lady beetles play in controlling plant pests, particularly aphids, is well known. Therefore, Seven-spotted Lady Beetles were introduced to Canada for biocontrol many times. However it appears that none of these intentional introductions resulted in an established population. In the mid-1970s, an unintentional introduction established a small population that rapidly grew, so that by the mid-1980s, from the east coast to Ontario, the seven-spotted was the common lady beetle in agricultural areas. By 1990, they were in British Columbia.

The largest populations are in human disturbed habitats such as city parks, agricultural fields and roadsides. After overwintering as adults, eggs are laid. The larvae feed on aphids and within a few weeks become adults. These adults mate and females lay eggs on plants infested with aphids. This generation becomes adults in the summer, some lay more eggs and others overwinter. There is no strong preference for particular species of plants or aphids.

Lady beetle populations have been best studied in agricultural fields. In Manitoba, populations of some native species, such as the Transverse Lady Beetle, declined after the arrival of the seven-spot. What has caused the declines in some species and why other species thrive in the same human modified habits is not clear.

Seven-spotted Lady Beetle, *Coccinella septempunctata* © Denis A. Doucet

Species spotlight - Nine-spotted Lady Beetle

Sixty years ago, one of the common lady beetles around family farms across southern Canada was the Nine-spotted (*Coccinella novemnotata*). Today, they still persist in southern Alberta and British Columbia, but are more likely to be found in natural vegetation along the edges of sand dunes than in agricultural fields. In southern Ontario and Quebec, they have not been seen for about 25 years. It is very likely they are extirpated in eastern Canada.

Recent reports of nine-spots often prove to be another species. Variable lady beetles, such as the Multi-coloured Asian, can have nine spots. In the west, nine-spots may lack spots. It is important to look for the dark strip in the middle of the back, the overall shape and size and the pattern behind the head to confirm the identification.

Both larvae and adults feed on aphids and other soft-bodied insects that feed on plants. Females search for plants that harbour concentrations of aphids and lay eggs. Like many lady beetles, nine-spots are generalists and will lay eggs on many species of plants, including many crops. The relative roles of competition with non-native species, disease, and changes in land use in the decline of this species are not clear. The Nine-spotted Lady Beetle has a general status Canada rank of Sensitive.

Results of general status assessment

The majority of Canada’s 166 species of lady beetles have Canada ranks of Secure (77 species, 46%, figure 14 and table 21). However, 9% have Canada ranks of Sensitive (15 species).

A total of 66 species (40%) have a Canada rank of Undetermined and one species (1%) have a Canada rank of Not Assessed. There are seven species (4%) of lady beetles ranked as Exotic that are established in Canada.

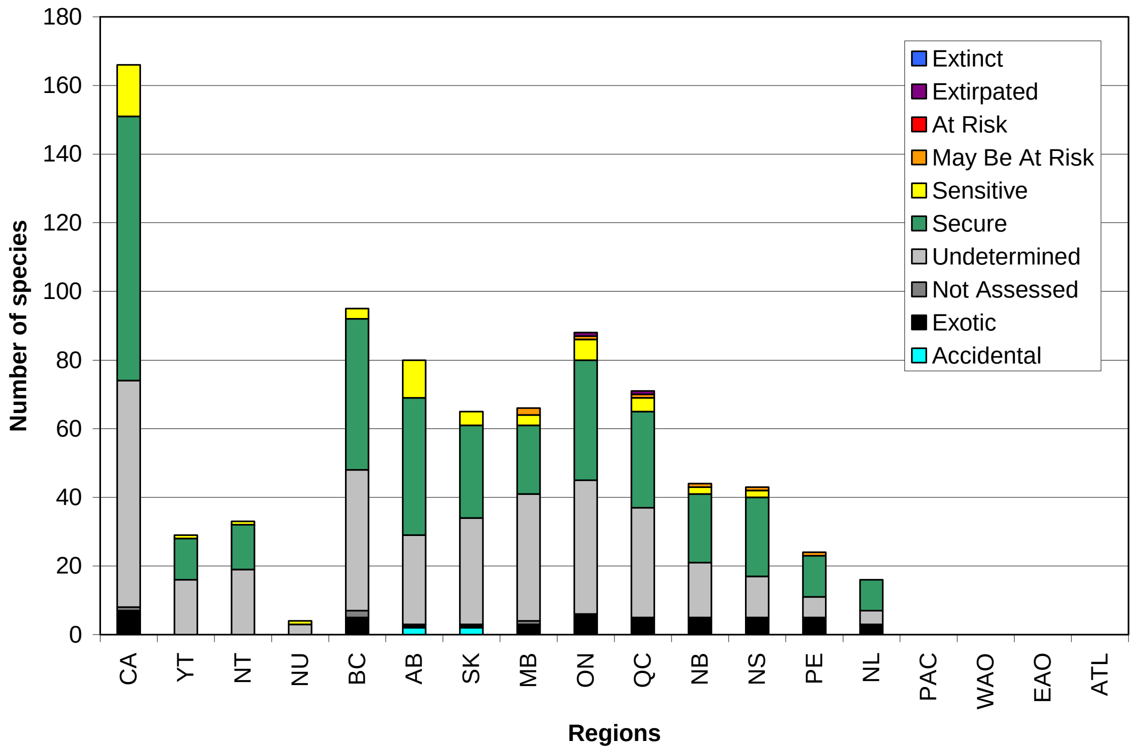

Figure 14. Results of the general status assessments for lady beetle species in Canada in the *Wild Species* 2010 report.

Table 21. Canada ranks of lady beetle species as determined by the National General Status Working Group.

	Canada rank	Number and percentage of species in each rank category
0.2	Extinct	0 (0%)
0.1	Extirpated	0 (0%)
1	At Risk	0 (0%)
2	May Be At Risk	0 (0%)
3	Sensitive	15 (9%)
4	Secure	77 (46%)
5	Undetermined	66 (40%)
6	Not Assessed	1 (1%)
7	Exotic	7 (4%)
8	Accidental	0 (0%)
	TOTAL	166 (100%)

Threats to Canadian lady beetles

Most attention has been focused on the coincidence of the decline of native species (e.g. Nine-spotted Lady Beetle and Transverse Lady Beetle) with the arrival and spread of non-native species such as the Seven-spotted Lady Beetle than other factors in the decline of several lady beetles. The relative importance of competition with non-native species compared with habitat and land use changes in the decline are not clear.

Conclusion

Although some studies have been done on lady beetles, much remains to be learned about the range and status of lady beetles in Canada. The potential effects of non-native species on changes in the geographic ranges of native species have led to increased attention to this group in the past 20 years.

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Bumblebees

Bombus - The genus of insects which includes the social and cuckoo bumblebees. These are winged pollinating insects which feed entirely from the pollen and nectar of flowers. Bumblebees are large, hairy and often brightly coloured.

Quick facts

- There are about 250 species of bumblebees in the world; 41 occur in Canada.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (94%) of bumblebees in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 6% have Canada ranks of May Be At Risk. However, it should be noted that most of the bumblebee species were ranked as Undetermined.

- Much of the range of bumblebees occurs in under-surveyed regions of the country. No bumblebees have Canada ranks of At Risk, because COSEWIC has not yet assessed any bee species, although the Rusty-patched Bumblebee (*Bombus affinis*) and Western Bumblebee (*Bombus occidentalis*) are currently being considered.

- Bumblebees have various adaptations to colder climates, making them excellent pollinators in adverse weather conditions. This includes a rare physiological capability to thermo regulate to achieve body temperatures well above ambient temperatures.

- The queen bee is the largest bee in the colony, followed by the workers (females) and drones (males).

- Bumblebees will not die if they use their stings, whereas honey bees do. Male bees do not possess stings.

Common Eastern Bumblebee, *Bombus impatiens* © Sheila Colla

Background

The genus *Bombus* (bumblebees) includes approximately 250 species found primarily in temperate regions of North America, Central America, South America, Europe and Asia. Bumblebees require three different habitats for nesting, overwintering, and foraging. Generally, nests can be underground in abandoned rodent burrows or above ground in trees or under grass mounds. Overwintering sites for mated queens consists of burrows in loose soil, sand, decomposing vegetation (including mulch) and rotting logs just a few inches below the surface. In some species, young queens overwinter at the same sites as their maternal nests. Foraging habitat can be anything from forest, meadow, urban gardens, bogs, agricultural fields, etc. Good foraging habitat has many suitable flowers which provide nectar and pollen sources throughout the spring, summer and fall. The common and easily recognized bumblebees are large, furry and corbiculate (i.e. with pollen baskets) bees.

Bumblebees are eusocial (i.e. colonial with a queen and worker castes, where the workers are the offspring of the queen). The colonies are annual; mated queens emerge from hibernation in the spring after overwintering and begin feeding. These queens search for a suitable nest site where they then begin their colonies. A few weeks after the queen's initial egg-laying, female workers emerge and begin foraging for the colony and feeding the brood. As the summer progresses, the colony reaches maximum worker production and begins producing males and potential queens. These reproductive individuals leave the nest and mate with bees from other nests. After mating, young queens enter diapause and overwinter. The males and the rest of the colony decline as fall approaches until they all die come frost. The timing of queen emergence and the length of the colony cycle differs widely by species. Bumblebees belonging to the subgenus *Psithyrus* are an exception as they do not produce a worker caste, but are social parasites (cuckoo bumblebees). Instead females usurp colonies of other species and propagate using the host species resources.

Bumblebees are extremely important pollinators for agriculture both in the field and in greenhouses. Unlike honeybees, they are able to forage under cold, rainy and cloudy conditions. This makes them excellent pollinators for a variety of crops in temperate regions such as tomatoes, berries, peppers, beans, etc. They are also extremely important pollinators for native flowering plants which provide food and shelter for native mammals and birds.

We have evidence in North America that some of our bumblebee species are going undergoing rapid decline. In fact, one species known from Oregon and California (Franklin's Bumblebee) has recently been listed by the International Union for Conservation of Nature (IUCN) as Critically Endangered. Currently, the suspected threats to wild bumblebees are habitat loss, urbanization and pollution, pesticide use, introduction of disease from managed bees and climate change.

Bumblebees are fascinating insects which have been studied by amateurs in gardens for centuries. They have also been the subject of many scientific studies in ecology and physiology. They are large, fuzzy and colourful. Although the females possess a sting, they are docile animals and can be observed busily flying from flower to flower. Bumblebees are extremely important pollinators of native flowering plants and agricultural crops, and are thus critical to the sustainability of ecosystems and their loss could impact many other species, including ourselves.

Status of knowledge in Canada

Bumblebees are relatively easy to identify in the field, are active during the day and are ubiquitous in many habitats with flowering plants. Their specific life history traits and habitat requirements are well known compared to most insects. However, little is known about their distribution. The specimens in museums and collections throughout Canada provide baseline data which we can analyze to determine population trends over time.

Bumblebees have been used as model organisms in Canada for many decades. In the 1970s and 1980s in particular, bumblebees were used to perform many experiments investigating community and evolutionary ecology. With the onset of Colony Collapse Disorder among managed honey bees, the importance of native pollinators has recently become an important issue. Bumblebees are the best known native bees and many projects are currently geared towards their conservation.

Because bumblebees are insects that live in colonies and many individuals are not reproductive, well designed long-term monitoring is critical to understanding the status of these species in the wild. Also, studies of bumblebee diseases and parasites are important to fully understand how the growing managed bumblebee sector is affecting wild populations. Further studies to better understand life history traits such as mating behaviour and overwintering requirements will help with the design of species-specific conservation plans.

Richness and diversity in Canada

Within Canada, bumblebee species richness is highest in regions of British Columbia, Alberta and the Yukon, where up to 34 of the 41 species have been reported (figure 15). Especially important bumblebee habitats are located in the alpine meadow regions of the country. Also with high species richness are southern parts of Saskatchewan, Manitoba, Ontario and Quebec. While all the species of Canadian bumblebees are found in other countries (i.e. mainly the USA, though some are holarctic), most of the native habitat for the majority of species is located in Canada.

Species spotlight - Rusty-patched Bumblebee

At the first signs of spring, Rusty-patched Bumblebee (*Bombus affinis*) queens can be found foraging on whatever plants they can find. Early sources of pollen such as willows and coltsfoot are crucial to the survival of this early-emerging species. Once the queen replenishes nutrients lost over the winter, she begins looking for abandoned rodent burrows to establish a nest. She lays eggs and forages to feed herself and the developing larvae until the first brood of workers hatch. The workers then take over all house-keeping and foraging duties and the queen focuses all her energy on producing eggs and building up the colony size. Towards the fall, the queen starts laying eggs which become males and young queens. These reproductive individuals go out and reproduce before the mated queens settle down for a long winter. Compared to other native bumblebee species, the Rusty-patched Bumblebee has one of the longest colony cycles, emerging as early as mid-March and continuing on until late October. As a result, they have cumulatively one of the largest colony sizes of all the other species and have relatively large body sizes to deal with the cool spring and fall weather.

As recently as 30 years ago, the Rusty-patched Bumblebee was one of the most common bees in meadows, urban areas, forests, and wetlands. In the past 10 years, less than five individuals have been spotted throughout its native range of southern Ontario and Quebec, despite intensive searches. Most recently, this species has been found only in Pinery Provincial Park, on the eastern shores of Lake Huron. As a result, this important pollinator is currently being considered for listing by COSEWIC under the *Species at Risk Act* and has been given the General Status Canada rank of May Be At Risk. Because of the species' distinctive rusty patch on the second stripe of its abdomen and its long colony cycle, it is a great species for the general public and avid gardeners to keep an eye out for.

Species spotlight - Common Eastern Bumblebee

The Common Eastern Bumblebee (*Bombus impatiens*) is a frequent flower visitor, spotted by many Canadian gardeners. It is distinctive as the only bumblebee with a single yellow stripe at the top of its abdomen (the rest of the abdomen is completely black). While the Common Eastern Bumblebee has always been quite common, in recent decades it has expanded its range eastward into Nova Scotia and increased in abundance in some places of its original range. For this reason it was given the General Status Canada rank of Secure. There are many natural history characteristics that make this bumblebee successful in today's changing landscapes. Firstly, it has adopted man-made objects as good nesting material. In urban areas, its colonies can frequently be found under decks, between cinder blocks, and sometimes even on apartment balconies! Common Eastern Bumblebees have a medium tongue length, meaning they can forage from hundreds of plant species, including native, introduced and crop plants. Queens also produce very large colonies of variable size workers, depending on the quality of available food.

The adaptability of this species to be successful in a variety of conditions has made it the perfect species for managed pollination of many food crops, in fields and in greenhouses. It is an especially good pollinator for tomatoes and sweet peppers, which require buzz pollination (honey bees are incapable of this behaviour). An unfortunate result of the domestication of this species for crop pollination may be that the Common Eastern Bumblebee becomes common in western Canada. Numerous commercial rearing companies are shipping this species all over North America for pollination of a variety of crops and in recent years, it has been spotted in the wild in British Columbia. Although this species is native to Canada, it poses a serious threat to the diverse bumblebee fauna of western Canada. Its success throughout its native range indicates it could prove to be quite the competitor for food and nest sites, potentially impacting other native bumblebee species.

Results of general status assessment

The majority of Canada's 41 bumblebess have Canada ranks of Undetermined (25 species, 61%, figure 15 and table 22). Fifteen species have Canada ranks of Secure (37%) and one species (2%) have a Canada rank of May Be At Risk.

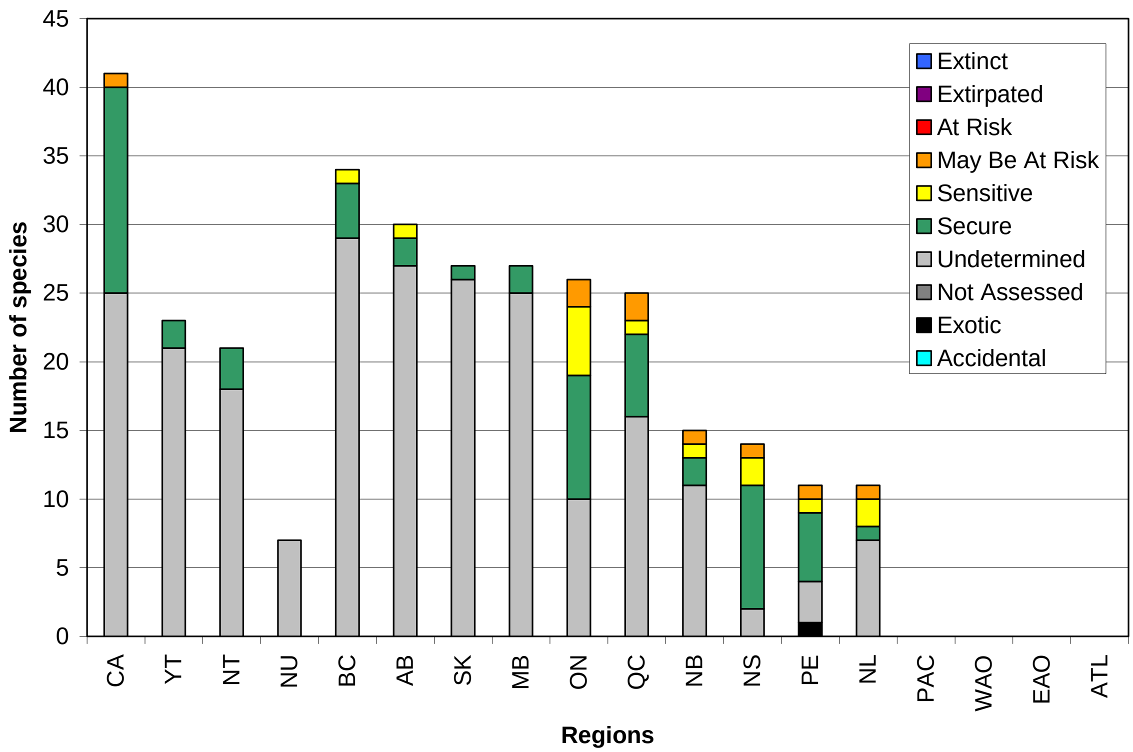

Figure 15. Results of the general status assessments for bumblebee species in Canada in the *Wild Species* 2010 report.

Table 22. Canada ranks of bumblebee species as determined by the National General Status Working Group.

	Canada rank	Number and percentage of species in each rank category
0.2	Extinct	0 (0%)
0.1	Extirpated	0 (0%)
1	At Risk	0 (0%)
2	May Be At Risk	1 (2%)
3	Sensitive	0 (0%)
4	Secure	15 (37%)
5	Undetermined	25 (61%)
6	Not Assessed	0 (0%)
7	Exotic	0 (0%)
8	Accidental	0 (0%)
	TOTAL	41 (100%)

Threats to Canadian bumblebees

Bumblebees require suitable habitat for the entire length of their colony cycle, as they only produce reproductive individuals at the end of the summer. This means that the entire colony needs good sources of nectar and pollen from a variety of flowers throughout the spring, summer and fall. Because they bring back food materials to the nest, bumblebees are highly susceptible to cumulative effects of pollution and pesticides (especially neonicotinoids) in their foraging habitats. They are also negatively impacted by climate change, invasive species which may compete for food plants (e.g. the Honey Bee (*Apis mellifera*)), and introduced disease from managed bumblebees used in greenhouse and crop pollination. Loss of food plants due to human land use practices, and invasive plant species also reduces habitat suitability for many bee species, including bumblebees.

Conclusion

This general status assessment shows that the majority (61%) of bumblebee species in Canada have a Canada rank of Undetermined. This is the result of a lack of survey work in most parts of the country. However some species have been well researched and have shown drastic and alarming declines in as little as 30 years. Accordingly, with ongoing survey work, it is possible that more species may be assigned a general status rank of May Be At Risk (currently 2%) or Sensitive.

While North American bumblebees are ubiquitous in historical collections, amateur naturalists and field biologists have only recently become interested in these creatures. Within the next few years, new identification keys and public awareness will likely result in a better understanding of this group of important pollinating insects.

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Black flies

Simuliidae - Family of insects in the Diptera order. This family includes any small blackish stout-bodied dipterous fly, which sucks the blood of human, mammals, and birds.

Quick facts

- There are over 1250 known species of black flies worldwide, of which 162 have been found in Canada.
- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (91%) of black flies in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 9% have Canada ranks of Sensitive.
- Black flies are found on all continents except Antarctica and are established in all of Canada's Provinces and Territories.
- Larvae live in flowing water. They strain fine particulate food matter from the water as it flows by using specially formed "fans" on their head.
- Only females bite; males feed mainly on plant nectar and are rarely observed.
- The average life span of a black fly is three weeks.

Simulium sp. © Tom Murray

Background

Black flies are insects belonging to the order *Diptera*, family *Simuliidae*. They are small (1-5 mm long) biting flies that are black, or yellowish orange, or brownish grey in colour. There are more than 1250 species known worldwide and 162 have been identified in Canada. Black flies occur almost anywhere that rivers and streams are present as they require moving water for the immature stages of their development. They are found throughout Canada, including the arctic regions.

Females have specialized mouths that include toothed “stylets” which are used for cutting skin when in search of a blood meal. Males do not bite and are rarely observed. Both the male and female depend on nectar from plants for their flight energy whereas females require blood for egg development.

Black flies lay their eggs in moving water. The female will produce 150-600 eggs which are laid directly on substrates in the water (e.g. rocks, vegetation) or dropped in the water as the female flies over (where they settle into the sediment). The larvae will attach to rocks or vegetation in the moving water using specialized hooks. The larvae have foldable “fans” around their mouths which expand to catch passing debris in the water such as bacteria, algae and small organic particles. The larva scrapes the debris caught in the fan into its mouth, repeating this process every couple of seconds. The larvae develop into pupae, an inactive phase of development during which time they do not feed. The pupae develop into adults and will float upward to the surface of the water in a bubble of air that is produced when they emerge from the pupae stage. The adults are ready to fly when they emerge from the water. The adult females will quickly go in search of a blood meal and soon after will lay their eggs. The average life span of a black fly is three weeks.

The bite of black flies causes suffering to humans and wild and domestic animals. The saliva of some species contains a toxin which in large quantities can cause anaphylactic shock and in rare cases, death. Farmers are particularly aware of the potentially devastating impacts of some black fly species. A study in northern Alberta found that an outbreak of the black fly *Simulium arcticum* in 1971 led to the death of 973 cows and an average weight loss 45 kg per animal in those that survived.

The breeding success of black flies is greatly affected by water pollution. Accordingly, measures to control black fly populations typically involve the dispersal of insecticides upstream of the area of the river or stream that is known to be a productive breeding ground. Similarly, because of the larvae’s susceptibility to both organic and inorganic pollution, black flies are often used in studies related to the environmental monitoring of freshwater contamination.

Status of knowledge

Globally, the *Simuliidae* are a poorly researched and relatively unknown family. The situation is very much the same in Canada. For example, a research trip in the Northwest Territories in 2006 organized by Doug Currie of the Royal Ontario Museum identified 43 species of black flies, nearly doubling the previous estimate of 22 species for the region. Much survey work remains to be done if we are to confirm which black fly species are established in Canada as well as their abundance and distribution.

The work of Roger W. Crosskey and Theresa M. Howard was until recently considered the taxonomic standard. Since the release of this publication however, taxonomic disagreement among black fly experts is increasing, leading to new challenges in the field of *Simuliidae* research.

Richness and diversity in Canada

British Columbia is the province with the most number of species of black flies (81 species, figure 16), followed by Alberta (72 species), Quebec (66 species) and Ontario (63 species). The province with lowest number of species of black flies is Nova Scotia (13 species).

Species spotlight - Simulium giganteum

Simulium giganteum is known in North America from just one specimen that was collected near Arviat, Nunavut. It is difficult to determine if this and other “rare” black fly species are indeed “rare” owing to the great challenges of conducting comprehensive surveys in Canada’s subarctic and arctic regions. Immense areas of land coupled with a lack of roads leads to high survey costs. Much research is necessary before we can confirm the distribution and abundance of *Simulium giganteum*. This species has a general status Canada rank of Undetermined.

Results of general status assessment

Most species of black flies had a Canada rank of Secure (72%, 116 species, figure 16 and table 23). However, 12 species were ranked as Sensitive (7%) and 34 species were ranked as Undetermined (21%).

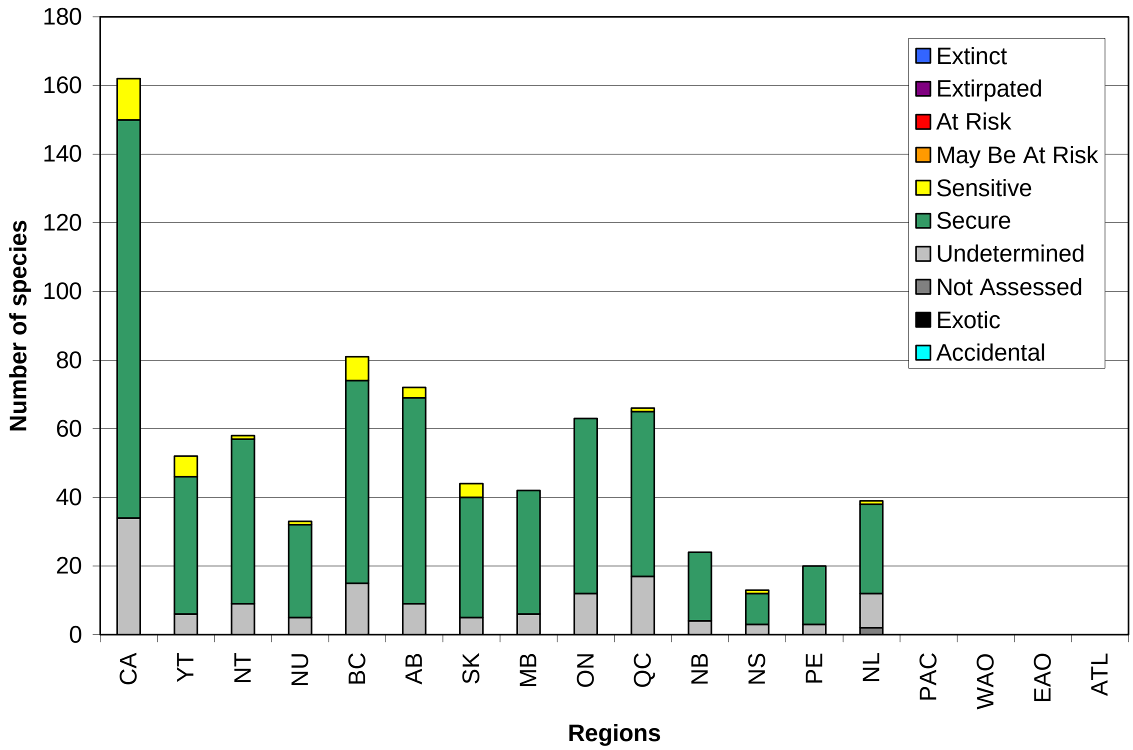

Figure 16. Results of the general status assessments for black fly species in Canada in the *Wild Species* 2010 report.

Table 23. Canada ranks of black fly species as determined by the National General Status Working Group.

	Canada rank	Number and percentage of species in each rank category
0.2	Extinct	0 (0%)
0.1	Extirpated	0 (0%)
1	At Risk	0 (0%)
2	May Be At Risk	0 (0%)
3	Sensitive	12 (7%)
4	Secure	116 (72%)
5	Undetermined	34 (21%)
6	Not Assessed	0 (0%)
7	Exotic	0 (0%)
8	Accidental	0 (0%)
	TOTAL	162 (100%)

Threats to Canadian black flies

The biggest known threat to black fly populations is water pollution caused by industrial and agricultural activity. Organic and inorganic chemicals released into streams and rivers can harm and/or destroy black fly larvae downstream. These pollutants include pesticides, fertilizers and effluent from mining and pulp and paper operations.

Conclusion

This report presents the first general status assessment of Canada's black fly species. Though important progress has been made in the field of *Simuliidae* research, much survey work, particularly in Canada's northern regions, is needed in order to confirm the richness and diversity of Canada's black flies.

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Horse flies

Tabanidae - Family of insects in the Diptera order. This family includes any of the swift, usually large dipterous flies with bloodsucking females.

Quick facts

- There are over 3700 species of horse flies worldwide, of which 144 have been found in Canada.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (85%) of horse flies in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 9% have Canada ranks of May Be At Risk and 6% have Canada ranks of Sensitive.

- Horse flies are found almost everywhere in Canada, except for the arctic islands.

- Small horse flies with banded wings (*Chrysops* species) are called “deer flies.”

- Most female horse flies need a blood meal in order to develop some of their eggs, but many do not need one to mature their first batch of eggs. Only the females are biting.

- Males have enormous eyes that cover most of their head, and they can often be found hovering over hilltops, waiting for females to visit.

- Larvae are predators of other invertebrates.

Bothersome Deer Fly, *Chrysops excitans* © Stephen P. L. Luk

Background

Horse flies are well known to most Canadians who venture out of urban areas in the summer. Even the thought of one of these large flies landing and biting can cause great anguish. In addition to causing physical and mental torment in humans and other animals, horse fly attacks have caused significant economic losses in the livestock industry.

Flies in this family are commonly known as horse flies or deer flies; but are also given other names such as clegs and stouts. The name deer fly specifically refers to species in the genus *Chrysops*; these flies are generally smaller than other tabanids, have banded wings, and golden or orange eyes with distinct black spots and blobs. Other horse flies, notably those in the genera *Hybomitra* and *Tabanus*, have eyes that are strikingly banded with iridescent greens and other colours. Interesting fact, the horse fly species *Hybomitra hinei* is the fastest known flying insect, having been clocked at 145 km/h for a brief instant as it took flight.

Only female horse flies bite. They feed on blood by using their knife-like mouthparts to slash skin, and then lap up the blood. Most females need a blood meal in order to develop at least some of their eggs, but many do not need one to mature their first batch of eggs. In these cases, enough nutrients are carried over as fat from the larval stage to complete the first egg-laying cycle. But blood meals are valuable because they allow females to lay many more eggs in subsequent cycles. However, based on studies elsewhere, some Canadian species (especially some *Atylotus* and *Apatolestes*) may never seek a blood meal. Many species have distinct preferences for certain hosts and for certain feeding locations on their hosts. Although female horse flies can home in on hosts using chemical cues (e.g. the carbon dioxide we breathe out), they rely primarily on their huge eyes to find appropriate targets.

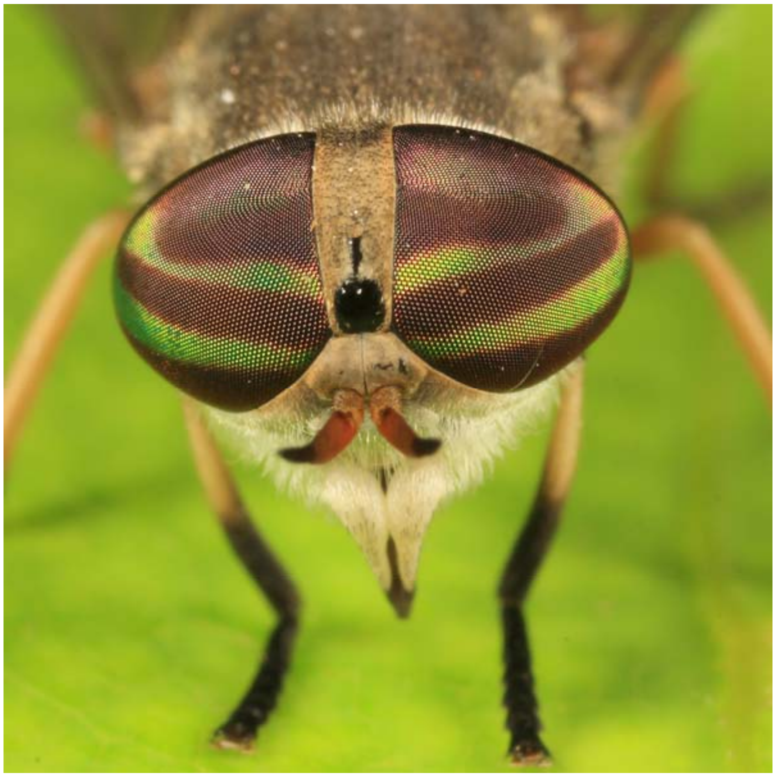
Biting horse flies have been implicated as vectors or potential vectors of a number of diseases, including tularemia, equine infectious anemia, vesicular stomatitis, hog cholera, encephalitis, anaplasmosis, trypanosomiasis, and filarial dermatosis of sheep.

All adult horse flies need to feed to sustain energy and reproduce, and the primary energy source for both sexes is sugar from flower nectar or from insect (mostly aphid) honeydew. Most species are active only on warm, sunny days when there is little wind. Some species (e.g. *Tabanus sackeni* and *Tabanus catenatus*), however, are normally crepuscular or nocturnal, and others have been observed coming to lights during the night.

Because male horse flies don’t seek out animals for blood meals, people don’t often encounter them. They can be found on warm summer mornings at their special mating sites, where they hover either singly or in small groups, or wait on vegetation or rocks for females to pass by. Many species meet on hilltops in order to find each other. On one small hilltop in southern Quebec, more precisely at the Rigaud hill, 17 species have been observed over a season! The various species share these sites by hovering at different heights above the ground, or by gathering in forest openings of different shapes and sizes. The eyes of males are even larger than those of females – they almost cover the entire head – and the males use them to detect and capture fast-flying females as they buzz by.

Females lay eggs in compact masses, usually on plant stems or on the undersurfaces of leaves overhanging water or wet soil, where the larvae of most species live. Up to 800 eggs are laid in a mass. Eggs hatch almost simultaneously and the larvae drop to the substrate below. Larvae are predators on insect larvae and worms; however, the food habits of *Chrysops* species are unknown. In Canada, larvae overwinter, and when full-grown, migrate to an appropriate pupation site, where they remain for 1-3 weeks before emerging as adults. In the far north, some larvae may take 2-3 years to mature.

Parasitoid wasps (*Chalcididae*, *Proctotrupidae*) that attack tabanid egg masses are the most important control agents; most egg masses are attacked, and often half of the eggs are consumed. Larvae and pupae are also parasitized by various wasps and flies, but extensive studies in Ontario showed that these parasites account for only 2% mortality. Adult horse flies are eaten by birds, dragonflies, robber flies, and wasps.



Tabanus similis © Tom Murray

Status of knowledge

Because of their biting habits, horse flies have had a certain amount of attention paid to them in entomological research, but most people would be surprised to find out how little we really know of the life history and ecology of most species in Canada. The broad picture of distribution is known for most species, but there are many regional gaps in basic distribution information. These gaps are reflected in the large number of Undetermined ranks at the provincial and territorial levels in this report.

The state of knowledge in Canada as of the 1980s was admirably summarized by Teskey (1990). This book includes identification keys, distribution maps, species accounts, and photographs of many species. For many species, the book remains the best account of the family, twenty years later. However, Thomas and Marshall (2009) have recently published an excellent online identification guide to the subfamilies *Chrysopsinae* and *Pangoniinae* east of the Rocky Mountains, which offers pictorial keys to adult females and up to date distribution maps for eastern species.

Older, regional identification manuals have been published for Ontario (Pechuman *et al*., 1961), Quebec (Chagnon and Fournier, 1943), the Maritimes (Lewis and Bennett, 1977; Thomas, 1978), and for the *Chrysops* of Alberta (Thomas, 1973). A manual of Illinois *Tabanidae* (Pechuman *et al*., 1983) is also noteworthy, since it provides, among other features, North American range maps and illustrations of and keys to larvae.

Richness and diversity in Canada

A total of 144 species have been found in Canada; species richness is highest in south-central Canada, peaking in Ontario (100 species, figure 17) and Quebec (75 species). Another five species are known to range close to the southern border and may eventually be found in Canada. The genus *Tabanus* is dominant in the southern half of North America and 30 species enter Canada, but these are generally restricted to the country's southern latitudes. Like *Tabanus*, species in the genus *Atylotus* are generally midcontinental in range; 12 species extend into Canada. The genus *Hybomitra*, on the other hand, dominates the north and is represented by 46 species in Canada. Three species of *Haematopota* are found in Canada, including the wide-ranging *Haematopota americana* and two much rarer or more reclusive species. The largely tropical and subtropical subfamily *Pangoniinae* is represented by only six species in the genera *Apatolestes*, *Stonemyia*, and *Goniops*; all of these species are confined to Canada's deep south. Deer flies (genus *Chrysops*) are more evenly distributed, and are represented by 45 species. Other members of the deer fly subfamily are *Merycomyia whitneyi*, a rare species known in Canada only from three localities in southern Ontario and Nova Scotia; and *Silvius gigantulus*, restricted to southern British Columbia.

Species spotlight - Merycomyia whitneyi

Merycomyia whitneyi is one of Canada's least-known tabanids. It is a large horse fly, 19-23 mm long, but is rarely seen, especially as an adult. This species is known from two sites in southern Ontario (Gilmour and Hamilton), but hasn't been seen in the province since 1947. This population is apparently quite separate (disjunct) from the species' primary range along the Atlantic lowlands. It was recently discovered in Nova Scotia, when three specimens were collected during studies of bogs in the southern part of the province. Normally, the larvae live in thick, flocculent silt deposits in stream backwaters. Because we know so little of this apparently shy species, it has been assessed for the time being as Undetermined in Canada.

Species spotlight - Chrysops excitans

This species is exciting in the sense that it is the commonest, most widespread, and generally most bothersome deer fly in Canada. Larvae live among moss and other moist vegetation at the edges of marshy lakes, peatland pools, and woodland swamps. It is found throughout Canada south of treeline, with the possible exception of the plains of southern Saskatchewan. Unfortunately for humans, its flight period is also extensive, from early June to late August.

Species spotlight - American Horse Fly

The American Horse Fly (*Tabanus americanus*) is the world's largest (22-27 mm long) horse fly, but it is also one of Canada's rarest. Its massive size, reddish legs, and white hair tufts make it easy to identify. Although its primary range is in the southeastern United States, there is an apparently small, isolated population in the Carolinian region of Ontario. It is ranked as May Be At Risk in Canada. Eggs are laid on foliage overhanging swamps, marshes and ponds. The larvae feed on aquatic insects.

Results of general status assessment

The majority (71%) of horse fly species have a Canada general status rank of Secure; 16% are not well known enough to rank (Undetermined), and 13% are considered May Be At Risk or Sensitive (figure 17 and table 24). Because of a general lack of information in many regions, the proportion of Undetermined species rises to over 26% when provincial and territorial ranks are examined. Those species considered Secure stay at much the same proportion as the national percentage (70%), whereas those ranked May Be At Risk or Sensitive drop to 4%.

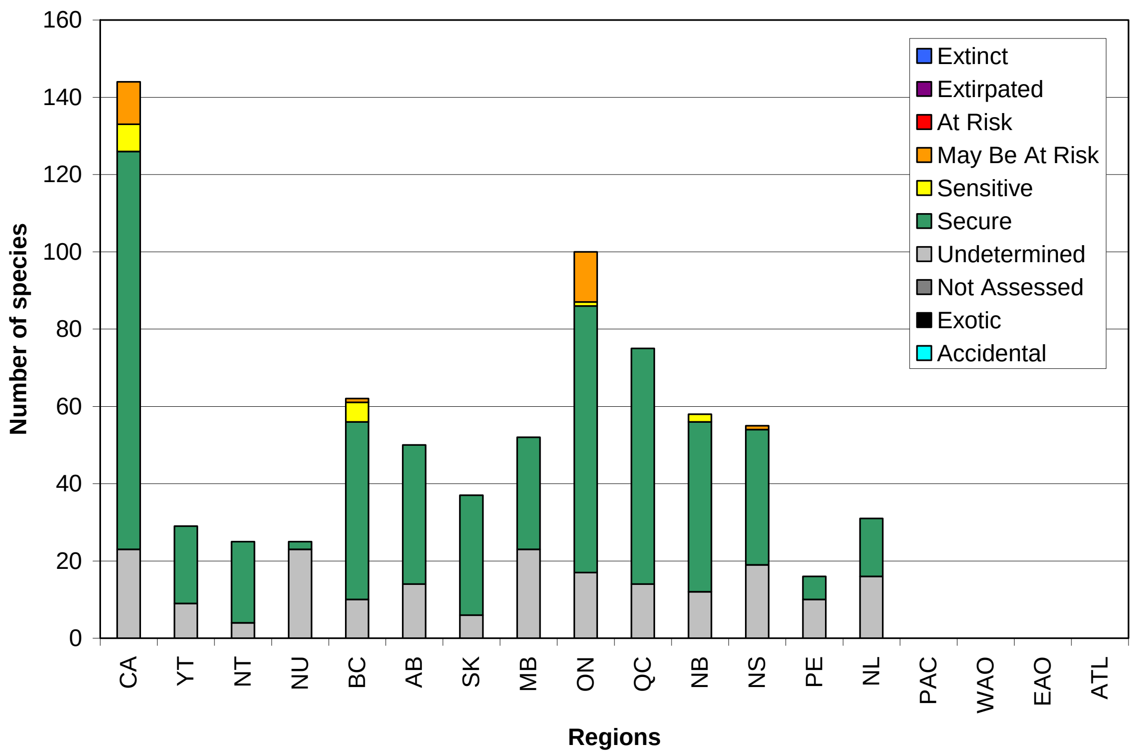


Figure 17. Results of the general status assessments for horse fly species in Canada in the *Wild Species* 2010 report.

Table 24. Canada ranks for horse fly species as determined by the National General Status Working Group.

	Canada rank	Number and percentage of species in each rank category
0.2	Extinct	0 (0%)
0.1	Extirpated	0 (0%)
1	At Risk	0 (0%)
2	May Be At Risk	11 (8%)
3	Sensitive	7 (5%)
4	Secure	103 (71%)
5	Undetermined	23 (16%)
6	Not Assessed	0 (0%)
7	Exotic	0 (0%)
8	Accidental	0 (0%)
	TOTAL	144 (100%)

Threats to Canadian horse flies

Species considered to have some levels of risk of extinction are concentrated in the extreme south of the country, especially in southern Ontario and British Columbia. As they are for other inhabitants of wetlands, the major threats to horse flies of conservation concern are probably the loss and degradation of wetland habitat. These threats include the draining and/or filling of wetlands, and degradation through pollution (including agricultural pesticides and fertilizers) and siltation.

Conclusion

While many horse fly species are abundant, widespread, and often painful nuisances, some species are rare and live in habitats that are declining or even endangered. Eighteen Canadian species (13% of the fauna) are ranked as May

Be At Risk or Sensitive. Most of these 18 species are confined to southern Ontario or the lowlands of southern British Columbia, regions where wetlands have declined and continue to decline.

Although there is some good published information on tabanids in Canada, much of the country is poorly known with regards to these flies. Future surveys in the north will fill in many knowledge gaps, and intensive surveys and research in the south will reveal much more about the species of concern.

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Mosquitoes

Culicidae - A family of slender, long-legged flies, belonging to the insect order Diptera (the "true flies"). Their bodies are covered in scales, the colour and position of which are used to distinguish species. They are notorious for the females' blood-feeding habit which is required to mature their eggs. The immature stages (eggs, larvae and pupae) are generally found in standing water.

Quick facts

- There are about 3000 species of mosquitoes in the world, of which 80 live in Canada.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the great majority (95%) of mosquitoes in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 5% have Canada ranks of Sensitive.

- A total of three species of mosquitoes are Exotic in Canada.

- Mosquitoes first appear in the fossil record during the Mid-Cretaceous (about 89-99 million years ago) and remains are often found in more recent amber deposits. A blood-fed mosquito trapped in amber figured in the movie Jurassic Park, but that individual would predate the first known fossil!

- Mosquitoes transmit a number of diseases to humans including malaria, arboviral encephalitis, yellow fever, and dengue, and they are also vectors of disease to livestock and wild animals.

- Although only females blood-feed, both males and females require sugar meals, which they generally get from floral nectar. In the process, mosquitoes can serve as pollinators – in the Arctic, they are important pollinators of orchids.

- Mosquito larvae are an important source of food for other aquatic organisms including fish, larval dragonflies, and other invertebrates. Adult mosquitoes are a source of food for insectivorous birds, bats, and other animals.

- Not all species require a blood meal – some are able to carry over enough nutrients from their larval stage to develop a batch of eggs without having to take a blood meal. This is common in northern species.

Permanent Marsh Mosquito, *Anopheles walkeri* © Tom Murray

Background

Mosquitoes, like all true flies, undergo complete metamorphosis: egg, larva, pupa, and adult. The first three stages are aquatic, whereas the adults are aerial or terrestrial.

Mosquitoes are often categorized according to the type of larval habitat in which they develop: containers (rain buckets, tires, tree holes), transient standing water (flooded areas, snowmelt pools, ditches), permanent standing water (ponds, swamps, marshes) and even slow moving streams. Each larval habitat is exploited by a particular set of mosquito species. For example, species capable of breeding in transient flooded areas generally have drought-tolerant eggs and may even require a drying out period before eggs will hatch.

Blood-feeding behaviours can also differ among species. Some species are able to use energy reserves gained during the larval stage to develop their first batch of eggs, and a few species are able to do this throughout their adult lives (e.g., *Wyeomyia smithii* and *Toxorhynchites rutilis*). However, in most species, the females must take a blood-meal in order to develop eggs. Some species blood-feed preferentially on amphibians and reptiles, whereas others specialize on birds or mammals. There are no species in Canada that are specialist human-feeders, but several of the more generalist feeders will include humans as a blood-meal source if humans are available.

Mosquitoes have been the target of many control programs over the years due to their role in disease transmission. Many *Anopheles* species are vectors of human malaria, whereas *Culex* species tend to carry enzootic arboviruses such as West Nile virus (WNV), St. Louis encephalitis, and Eastern Equine encephalitis (EEE). Historically, *Anopheles quadrimaculatus* was a vector of human malaria in southern Ontario (Fisk, 1931), but with improved sanitation and the use of window screens, endemic malaria transmission in Canada has disappeared.

Status of knowledge

Despite the fact that mosquitoes have attracted some attention, the life history, distribution, and habitats requirements of many Canadian mosquito species are not well known. While many people are familiar with the nuisance species or those that transmit disease, the majority of species do not feed on humans at all. Many of these species are rarely collected and their life history and larval breeding habitats are poorly understood, making assessment of their status in Canada difficult.

Because of the recent introduction of West Nile virus to Canada in 2001, some provinces have initiated mosquito surveillance programs, which have contributed greatly to our knowledge of species distribution and abundance in those areas. The last major mosquito survey occurred during the late 1970s after an outbreak of St. Louis encephalitis virus and resulted in the publication of The Mosquitoes of Canada by Wood *et al*. (1979), which remains an invaluable resource for information on mosquitoes in Canada to this day.

Little is known about certain *Aedes* species, such as *Aedes implicatus* and *Aedes intrudens*, apparently because they are the first to emerge in the spring and the adults are short-lived. Thus, a lack of early spring sampling may be causing these species to appear rarer than they actually are. How biologists sample mosquitoes also has had a significant impact on the knowledge of mosquito species distribution and abundance. For example, many surveys use only light traps to collect adults. However, not all species are attracted to light and therefore go undetected in these surveys. Sampling of larval habitat is essential in these cases and yet, for some species the larval habitat remains unknown.

The status of knowledge about mosquitoes differs significantly among provinces and territories. Newfoundland and Labrador recently coordinated a project through Memorial University that looked at changes in mosquito ecology resulting from land use changes and the potential for West Nile virus in Newfoundland (Hustins, 2006). This study resulted in one of the best data sets for mosquito distribution and abundance of any province or territory and will provide an excellent foundation for future studies. Other recent surveys in the Maritime Provinces have added several species of mosquitoes to each provincial list, and greatly increased our knowledge in general. On the opposite end of the spectrum is Nunavut, a vast land with an abundance of mosquitoes. Very little is known about the mosquito fauna in the territory – only 11 species have been confirmed to occur there, compared to 33 in the Northwest Territories and 31 in the Yukon.

Richness and diversity in Canada

Within Canada, mosquito species richness is highest in Ontario and Quebec, with 64 and 50 species, respectively (figure 18). There are many species (*Aedes triseriatus*, *Aedes hendersoni*, *Anopheles barberi*, *Toxorhynchites rutilus*, *Orthopodomyia alba*, and *Orthopodomyia signifera*) whose larvae occur in large tree holes found in older hardwood forests in southern Ontario and Quebec, particularly in the Carolinian zone. All of these species are rare (except *Aedes triseriatus*, whose larvae also occur in artificial containers), and the conservation of this habitat is likely a requirement for their continued survival in Canada. British Columbia is also rich in mosquitoes, with 46 species. Some Canadian species (*Aedes togoi*, *Aedes aboriginis*, *Aedes nevadensis*, *Aedes aloponotum*, *Aedes sierrensis*, and *Aedes melanimon*) are known only from British Columbia.

Despite the tremendous hordes of mosquitoes that are common in the northern territories, species diversity is lowest in these regions. Some *Aedes* species are common only in the north (*Aedes impiger*, *Aedes nigripes*, *Aedes churchillensis*, and *Aedes rempeli*) and their eggs require long periods of extremely cold temperatures in order to hatch the following year.

Species spotlight - Puget Sound Mosquito

The Puget Sound Mosquito (*Aedes aloponotum*) is only known in Canada from the southwestern corner of British Columbia. It is a large, light brown mosquito with sharp white bands on the legs and abdomen. The larvae have been found in the woodlands of the lower Fraser Valley and southern Vancouver Island. In the Fraser Valley, larvae were found in woodland pools and open pools with grassy bottoms from March until May. Adult females bite humans readily, particularly in the evening. But very little is known about this species – we are ignorant about mating behaviour, host preference and its ability to transmit disease.

In the Fraser Valley, woodland habitat is being developed rapidly, putting this mosquito at risk of extirpation in both British Columbia and Canada. Although it was once found at Burnaby Lake, it has not been collected there in the last 10 years (Belton, 1978; Belton, personal communication). The geographic distribution of *Aedes aloponotum* does extend south into the USA, but is limited there as well, restricted to western Washington and Oregon. Recent abundance data are not available and the status of this species in this rapidly developing part of the USA is currently unknown. In Canada, this species has a general status rank of Sensitive.

Species spotlight - Permanent Marsh Mosquito

The Permanent Marsh Mosquito (*Anopheles walkeri*) is known in Canada from Saskatchewan to Nova Scotia and the larvae occur primarily in large marshes and wetlands with stable, permanent water levels. Once considered the most abundant *Anopheles* species in southwestern Ontario (Wood *et al*., 1979), it is now one of the least common, except in large conserved marshes, such as those in Point Pelee National Park, and Rondeau and Long Point Provincial Parks (Thielman and Hunter, unpublished data). Once common in Wainfleet, Ontario, *Anopheles walkeri* is now rarely collected in the area, and the large marsh (known as the Wainfleet Marsh) was drained for agricultural purposes sometime after the 1970s. A few specimens have been recently collected from the nearby Mud Lake Conservation Area, but the dominant *Anopheles* mosquitoes there, and in the nearby Wainfleet Wetlands Conservation area are *Anopheles punctipennis* and *Anopheles quadrimaculatus*.

Anopheles walkeri is the only *Anopheles* species to overwinter in the egg. Overwintering eggs must be subjected to a lengthy period of cold conditioning before they will hatch. According to weather station data for the Niagara region, the average temperatures in January and February are 5 to10 degrees warmer now than they were 40 years ago. This means that the eggs of *Anopheles walkeri* may not be getting cold enough temperatures for as long as is necessary for the eggs to hatch the following spring, resulting in population declines. Recent studies have also shown that this species may require large, pristine marshes and wetlands for their survival (Thielman and Hunter, unpublished data). While *Anopheles punctipennis*, *Anopheles quadrimaculatus* and *Anopheles walkeri* often occur together in this type of habitat, *Anopheles punctipennis* and *Anopheles quadrimaculatus* also occur in roadside ditches, forest pools, and artificial containers. *Anopheles walkeri* is only collected from large bodies of water with stable water levels and emergent vegetation such as cattails.

Species spotlight - Pitcher Plant Mosquito

The Pitcher Plant Mosquito (*Wyeomyia smithii*) is known in Canada from Saskatchewan to Newfoundland. It is an interesting species whose larvae occur in the rainwater that collects in the pitcher-shaped leaves of the Northern Pitcher Plant (*Sarracenia purpurea*). This plant is found in bogs throughout the boreal regions of Canada and *Wyeomyia smithii* occur almost everywhere the Northern Pitcher Plant is found, except British Columbia, Alberta and the Northwest Territories. This species overwinters as third instar larvae, frozen inside the water in the leaves of the Northern Pitcher Plant. No blood feeding has ever been recorded for this species, even though their proboscis appears to be fully functional and capable of taking blood.

The Northern Pitcher Plant is usually recognized as a carnivorous plant. Pitcher Plant Mosquitoes do not seem to have a special adaptation to prevent them from being digested by the plant. Instead, the plant does not seem to do a lot of active digestion by itself, but relies mainly on the aquatic community of bacteria, protists, and midge and mosquito larvae to do the digestion for it, using the minerals released during predation and digestion.

Results of general status assessment

The report *Wild Species* 2010 marks the first assessment for mosquitoes. The rankings were completed in March 2009. They were based on a comparison of historical data using published literature and current data obtained from recent surveys, primarily for West Nile virus surveillance. The Northwest Territories, Newfoundland and Labrador, Prince Edward Island, New Brunswick and Ontario had the most rigorous datasets, having recently conducted thorough mosquito surveys that involved both larval and adult collections. Other provinces had fewer data available, because of either a lack of sampling, limited duration or type of collections, or the lack of publishing results of mosquito surveillance projects. The amount of abundance data, old and new, varied among provinces and territories – in general, there was very little available. This resulted in a large number of species being assigned a rank of Undetermined.

The majority of Canada's 80 species of mosquitoes have Canada ranks of Secure (63 species, 78%, figure 18 and table 25). Three species (4%) have a Canada rank of Sensitive. There are 11 species (14%) with a rank of Undetermined.

Three species (4%) have Canada ranks of Exotic since they were recently introduced from Asia. *Ochlerotatus japonicus* was first discovered in 2001 in the Niagara Region, has since spread to Quebec and Nova Scotia and is now well established. *Aedes togoi*, another resident of Japan, was first discovered along the southern British Columbia coast in the 1950s. *Aedes albopictus* is known from only two specimens collected in 2001 in the Niagara Region and thus may not have become established in Canada.

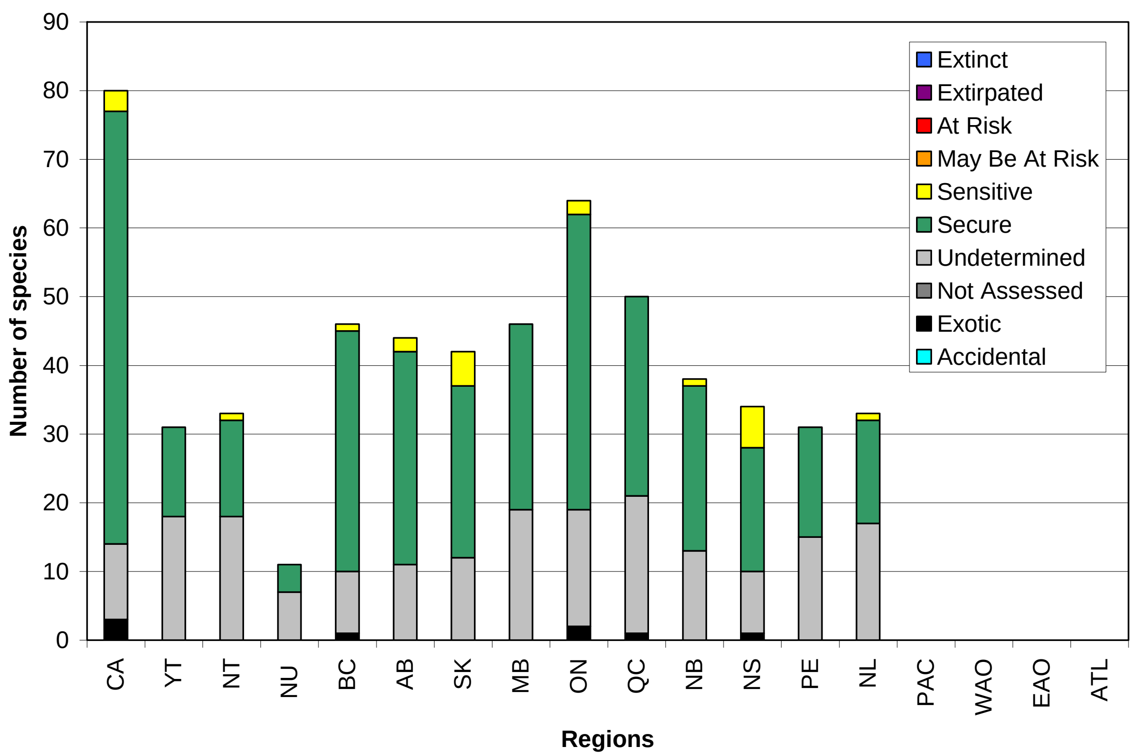

Figure 18. Results of the general status assessments for mosquito species in Canada in the *Wild Species* 2010 report.

Table 25. Canada ranks of mosquito species as determined by the National General Status Working Group.

	Canada rank	Number and percentage of species in each rank category
0.2	Extinct	0 (0%)
0.1	Extirpated	0 (0%)
1	At Risk	0 (0%)
2	May Be At Risk	0 (0%)
3	Sensitive	3 (4%)
4	Secure	63 (78%)
5	Undetermined	11 (14%)
6	Not Assessed	0 (0%)
7	Exotic	3 (4%)
8	Accidental	0 (0%)
	TOTAL	80 (100%)

Threats to Canadian mosquitoes

Ask most Canadians if they would be sad if mosquitoes became extirpated or extinct and the reply will be “Why no, that would be great!” This view is based on the misconception that all mosquitoes are bad, either because they are annoying nuisances or because they may transmit diseases to humans. The fact is that, of 80 species in Canada, the majority would prefer to feed on animals other than humans. Currently, the major vectors of human disease in Canada are *Culex pipiens* and *Culex restuans* (in the east) and *Culex tarsalis* (in the west), all of which are competent vectors of West Nile Virus. Occasionally, *Culiseta melanura* transmits Eastern Equine Encephalitis. There are other non-human mosquito-borne diseases such as dog heartworm, transmitted by *Aedes* mosquitoes. However, an increased use of pesticides against disease-carrying mosquitoes may potentially upset the balance by killing harmless mosquitoes unnecessarily, while at the same time artificially selecting for pesticide-resistance among vector mosquitoes.

Probably one of the greatest threats to overall mosquito biodiversity is the destruction and degradation of wetlands. Water pollution and acidification will likely have a negative impact on many sensitive mosquito species. On the other hand, increased urban sprawl may be encouraging an increase in a number of species that do well in and near human dwellings. One such example is the rapid expansion of the range of the invasive species *Ochlerotatus japonicus* (Thielman and Hunter, 2006). *Ochlerotatus japonicus* and *Aedes albopictus* (currently a rare invasive in Canada) may outcompete native species (for a review, see Armistead *et al*., 2008).

Conclusion

In closing, it should be noted that the majority of work currently being done on mosquitoes in Canada is in relation to arboviral disease transmission. The problem with this focus is that often only species known to transmit diseases are identified and the rest are ignored, making accurate assessments of the status of many of our species difficult to establish.

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Selected macromoths

Lepidoptera - Order of insects that includes moths and butterflies. They can be distinguished from all other insects by their two pairs of scale-covered wings, which are often brightly coloured. Lepidopterans undergo complete metamorphosis: eggs are laid, from which larvae hatch, and a pupal stage follows, during which the final adult form takes shape. Moths are mostly nocturnal.

Quick facts

- About 180 000 species of lepidopterans have been described, but hundreds more are discovered each year. The total number of species in the world is probably between 300 000 and 500 000. About 5300 species are known from Canada, 5000 of which are moths. Only 236 species were assessed in this report.

- Moths represent about 90% the lepidopterans (the others are butterfly species). Moths are then much more diverse, but are less well known. In this report, only some selected groups of moths were assessed.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (84%) of selected macromoths in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 11% have Canada ranks of Sensitive and 5% have Canada ranks of May Be At Risk. One species has a rank of At Risk following a detailed COSEWIC assessment.

- Of the assessed species, seven species in total are Exotic in Canada, including the Asian Silk Moth (*Bombyx mori*).

- Most adult moths are nocturnal, and are attracted to artificial lights.

- Although moth caterpillars are often blamed for eating woollen clothing, only two out of the many thousands of moth species actually feed on wool.

Cecropia Moth, *Hyalophora cecropia* © Alan Chin-Lee

Background

Moths are usually nocturnal and less brightly coloured than their day-flying cousins, the butterflies. They are so diverse and poorly known that the majority of species have probably not even been discovered and described. The earliest fossils of lepidopterans are about 190 million years old, but most evolutionary radiation in the group occurred at the same time as that of the flowering plants, in the Cretaceous Period, 65 to 145 million years ago. Because the butterfly branch of the lepidopterans is embedded in the midst of the family tree, the moths as a whole are not a formal taxonomic group. For convenience, moths are often divided into macromoths (usually larger species) and micromoths (the primitive side of the family tree; usually very small species). They are formally divided into 118 families. At the species level, many lepidopterans can be identified by their wing patterns; others require examination of the complex structures of the genitalia, which usually have very good distinguishing characters.

Most moth groups are too poorly known to be assigned General Status ranks or even do a species list; however the giant silk moths (Family *Saturniidae*, 23 species), silk moths (Family *Bombycidae*, 3 species), sphinx moths (Family *Sphingidae*, 58 species), tiger moths (Family *Erebidae*, subfamily *Arctiinae*, 95 species) and underwings (Family *Erebidae*, genus *Catocala*, 57 species) are well enough known that they are dealt with in this report. It is hoped that more moth groups will be included in future versions of this report as they become better known.

Like all other insects, adult lepidopterans have six legs and three major body segments: the head; the thorax, with legs and wings and the muscles to power them; and the abdomen, with the majority of the digestive and reproductive organs. All adult lepidopterans have two pairs of scale-covered wings, which set them apart from all other insects. The differences between moths and butterflies are not always readily apparent. Butterflies have thin, clubbed, or hooked antennae, tend to be brightly coloured and fly during the day, whereas moths often have feathered antennae, and most fly at night and tend to be drably coloured. However, there are many exceptions to this pattern and no single characteristic will always separate all species of moths from all butterflies.

The vast majority of a moth’s life is spent as a larva, or caterpillar. Caterpillars of most species feed on living plant parts, especially leaves, but some feed on flowers, buds, seeds, stems, roots, and bark. Some feed externally; others are miners or borers. A few species stimulate gall formation on their host plants. Many species are host-specific; others feed on a wide variety of plants. The larvae of a few species feed on fungi or detritus, and a few are predators or parasites. Larvae are usually voracious feeders that have to store up most of the food reserves required by the adults to disperse and reproduce. Some adult moths feed on nectar, but many do not feed at all, and most live for only one or two weeks. Adults of most species have a short, specific flight period, but some species have multiple broods and may be found as adults over the whole summer. Most species spend the winter in dormancy as either an egg or a pupa, but some overwinter as larvae or adults.

Moths form an essential part of most terrestrial ecosystems. As herbivores, they help to regulate plant growth and when their population levels are high they can drive plant community succession. Many adult moths are important pollinators. Larvae and adults are major food sources for many other animals, including songbirds, bats, and other insects. A few species of moths are such good competitors with humans that they are considered pests. This category includes pests of food crops, trees and timber, and stored food products. Although only two moth species have larvae that eat silk and wool products, this extremely rare feeding habit is often attributed in error to the whole group. Silk itself comes from human exploitation of the Asian Silk Moth (*Bombyx mori*).

Moths are renowned for their sense of smell. The females of most species release complex, species-specific chemical compounds (pheromones), which can be detected by males from great distances. The males locate females by following their scent plumes, often producing their own pheromones, which they use at close range during courtship. Some moths also have a well-developed sense of hearing, which has evolved as a method to detect the sonar of bats, which are important predators of moths. One group, the tiger moths, actually produce sound to interfere with the signals of bats or to advertise the fact that they are unpalatable to predators.

Giant silk moths (*Saturniidae*) include the largest resident moths in Canada. They typically have stout, furry bodies; small heads with vestigial mouthparts; and large wings, often with brightly coloured spots that mimic the eyes of owls and snakes. Larvae of saturniids usually bear scoli (spiny warts), and some can cause skin irritation. Silk moths (Family *Bombycidae*) include, among others, the Asian Silk Moth, an Exotic species in Canada. Sphinx moths (*Sphingidae*) have stout, pointed bodies with elongate forewings and small hindwings. Most larvae of sphinx moths have a characteristic horn at their tail end; when disturbed, some species rear up in a characteristic pose reminiscent of the ancient Egyptian sphinx, hence the common name for this group. Tiger moths (*Erebidae*: *Arctiinae*) are medium-sized moths, usually with brightly colored, patterned wings. Many species have warning coloration and possess the ability to produce sound with a specialized structure (the tymbal), which is used to characterize the group. They have historically been treated as a separate family (the *Arctiidae*), but have recently been placed as a subfamily of the *Erebidae*. Their larvae are usually densely hairy and include the well-known woolly bear caterpillars. The underwings (*Erebidae*: genus *Catocala*) are large moths with cryptically patterned forewings, and usually brightly coloured hindwings. Their larvae are also usually cryptically coloured.

Status of Knowledge

Overall, moths are not very well known in Canada; with the state of knowledge being comparable to where our knowledge of birds was some 200 years ago. Even basic species descriptions and occurrence information is scattered among hundreds of obscure scientific publications and museum drawers. Unlike many vertebrate groups, there is no single guide book to all the species that occur here. Good modern works exist for a few groups, including the saturniids and sphingids, but not for the majority of moth families. We do not even have a comprehensive national moth species list; although provincial lists have been produced for British Columbia, Alberta, Quebec, and the Yukon.

For most of the moth species included in the *Wild Species* 2010 report, the host plants are known and their distributions are reasonably well-known;

however, for some species, we still do not know enough about them to assign general status ranks other than Undetermined. This report covers only 236 species out of the approximately 5000 species thought to occur in Canada, all belonging to the better-known macromoth group. Our knowledge of the remaining species is generally rather poor except for a few pest species.

Moths are better known in eastern Canada than in the west and the north, and overall the macromoths are far better known than the micromoths. The efforts of amateur collectors have been especially important in learning what we do know about moths in Canada. Much more inventory work and research is required to fully document the moth fauna, and to better understand their distributions and life cycles. Without this information, many species may be threatened with extirpation from Canada before we even know of their existence.

Richness and diversity in Canada

Approximately 5000 moth species are known from Canada. However, many more remain to be discovered, and the number that actually lives here is thought to be closer to 7000. This report covers only a small percentage of that diversity (5 groups for a total of 236 species). Major hotspots of moth diversity are the eastern deciduous forests with their high plant diversity, and arid habitats in the west. Some species of moths are known in the world only from the unglaciated tundra of Yukon, Northwest Territories, and Alaska.

Species spotlight - Mountain Tiger Moth

The Mountain Tiger Moth (*Pararctia yarrowii*) is emblematic of Canada's western cordilleran region, inhabiting lofty peaks and rocky alpine meadows. When Richard Stretch named this species in 1874, he described it as "the most beautiful of the American Arctians [tiger moths]". Like most tiger moths that occur in the alpine and arctic regions, they are only rarely observed, probably a result of the fact that the larvae (collectively called woolly bears) take multiple years before they are full-grown and ready to pupate – an adaptation that has permitted this species to thrive on low-growing plants during the short alpine summers. Unlike the relatively long-lived larvae, the adult moths live only for several weeks, and do not feed, living on the fat stores accumulated as a larva. Larvae spend winters beneath rocks, and talus slopes and rock fields are therefore important components of this species' habitat.

Like many alpine moths, the Mountain Tiger has evolved to fly during the daytime, since most nights are too cold for flight. Females spend considerably less time flying than males; immediately following emergence from the pupa, females seek higher ground, such as the top of a boulder, from which to perch while emitting mating pheromones. These pheromones are produced from the tip of the abdomen, and any males on their patrol flights will soon narrow in on the calling female to mate. The life history is still incompletely known, but eggs are probably laid indiscriminately among low-growing plants, which provide food for the young larvae.

The Mountain Tiger Moth is found from Yukon southward through the Rocky Mountains to northern Utah, and in the west portion of British Columbia and the Washington Coast Ranges. Known localities are few, and this beautiful moth still remains to be documented in many of western Canada’s mountain ranges. It is ranked as Secure in Canada.

Species spotlight - Western Poplar Sphinx

The Western Poplar Sphinx (*Pachysphinx occidentalis*) found in Canada only in the wooded parts of the arid grasslands region of southern Alberta and western Saskatchewan, is an enigmatic moth for a number of reasons. Until recently, they were thought to be a pale population of the common and widespread Big Poplar Sphinx (*Pachysphinx modesta*). However, DNA data indicates that these are two different species, and preliminary rearing studies support this. It still remains to be determined whether or not this Canadian prairie moth is the same species as the southern (USA) species *Pachysphinx occidentalis*, or an undescribed species needing an entirely new name. Much remains to be learned about our moths, even ones as large and showy as this one! Above all else, the Western Poplar Sphinx is simply one of our most impressive and beautiful insects. For the moment, it is ranked as Secure in Canada.

The Western Poplar Sphinx may also be the largest insect in Alberta, in terms of mass, and perhaps the largest in all of Canada. The mature larvae are huge green “hornworms”, so-called because of the short spine-like “tail” on the rear of the larva, and found on the larvae of most species of sphinx moths. The mature larvae are also decorated with a series of oblique white lines along the flanks. Although large and voracious, they are harmless, and neither sting with their “horn” nor occur in large enough numbers to cause damage to trees. These larvae are rarely encountered until they mature in late summer, at which time they stop feeding, leave the trees where they have spent the summer and wander about the ground looking for a suitable place to burrow, pupate and spend the winter. They re-appear in spring as adult moths once the cottonwood trees leaf out. The adults are active only at night, and are most often encountered in the morning, resting near the lights that attracted them the night before. Adult Western Poplar Sphinx have poorly developed and apparently non-functional mouthparts, and thus are unable to feed. They must live on whatever resources they were able to store as fat during the larval stage, and are thus short-lived, living only long enough to find a mate and start the cycle anew.

Western Poplar Sphinx, *Pachysphinx occidentalis* © Gary Anweiler

Results of general status assessment

The *Wild Species* 2010 report marks the first assessment for any moth species. These rankings were completed in March 2010, and reflect the classification and available knowledge at that time. Among the 236 species that were assessed, 155 species were ranked as Secure (66%, figure 19 and table 26), 20 species were ranked as Sensitive (8%), nine species were ranked as May Be At Risk (4%). One species in ranked as At Risk following a detailed COSEWIC assessment of Endangered, namely the Bogbean Buckmoth (*Hemileuca* sp.), a new species that still does have an official scientific name.

A total of 29 species (12%) were Undetermined, while 15 species (6%) where Accidental. Also, seven species (3%) are Exotic in Canada. The vast majority of Canadian moth species remain unranked, pending better knowledge of the group.

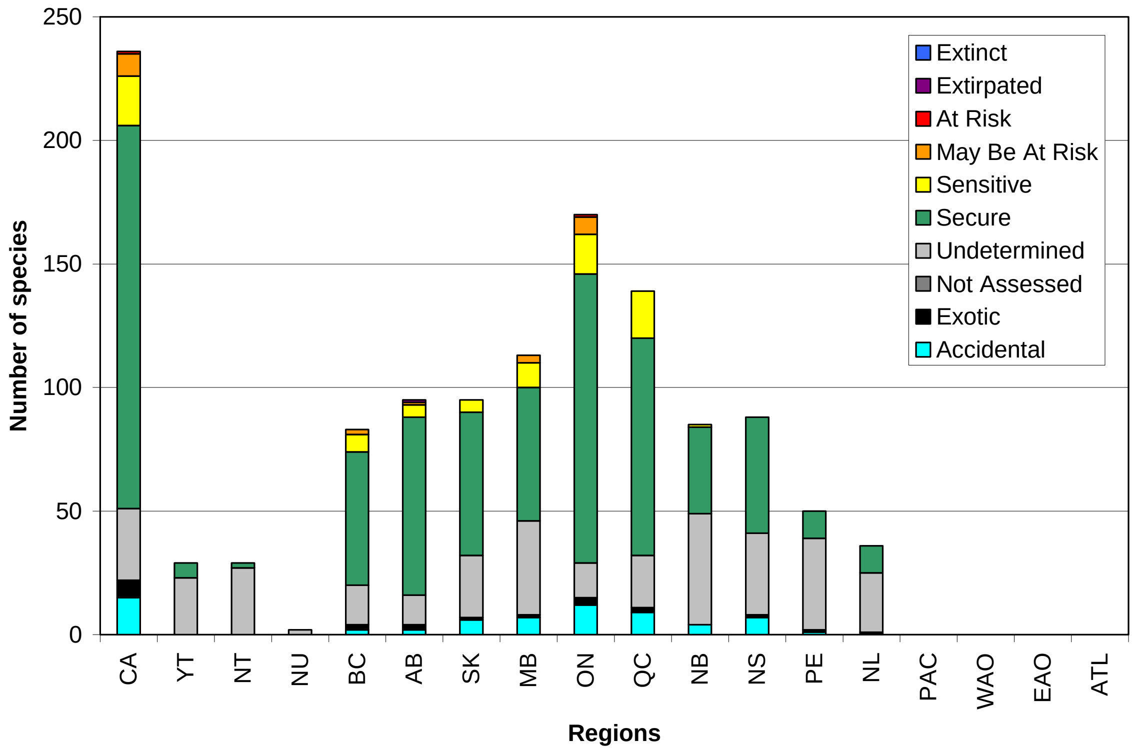

Figure 19. Results of the general status assessments for selected macromoth species in Canada in the *Wild Species* 2010 report.

Table 26. Canada ranks of selected macromoth species as determined by the National General Status Working Group.

	Canada rank	Number and percentage of species in each rank category
0.2	Extinct	0 (0%)
0.1	Extirpated	0 (0%)
1	At Risk	1 (1%)
2	May Be At Risk	9 (4%)
3	Sensitive	20 (8%)
4	Secure	155 (66%)
5	Undetermined	29 (12%)
6	Not Assessed	0 (0%)
7	Exotic	7 (3%)
8	Accidental	15 (6%)
	TOTAL	236 (100%)

Threats to Canadian macromoths

By far the greatest threat to moths is habitat destruction from agriculture, forestry, mining and other industrial activities, urbanization, and climate change. Other threats, of varying severity, are pesticide use, pollution, artificial lighting, and the spread of non-native species. The abundance and distribution of most moth species in North America is not well enough known to allow measurement of declines. However, threats can be anticipated for species particularly dependent on rare host plants, and for those associated with seriously threatened habitats such as sand dunes, the Garry Oak and semi-desert ecosystems of southern British Columbia, and the oak savanna and Carolinian ecosystems of southern Ontario.

The effect of insect collectors has sometimes been raised as a potential threat to moth populations, but there are no documented cases of moth species in Canada being adversely affected by such activities. In fact, the overwhelming opinion of informed environmentalists is that responsible collecting does far more benefit, in terms of providing information, than harm. The only way that collectors could possibly exert enough pressure to threaten an insect population would be if the population was already so small that it was in serious trouble from other factors.

Conclusion

Moths are a major component of biodiversity, so they form an important part of the natural environment. They have a huge capacity for reproduction, so most species are relatively resilient to population fluctuations. However, the vast majority of species are too poorly known to allow an assessment of how they are affected by human activities, and what might be done to mitigate the damage that humans cause. In most cases, the best that can be done at this time is to attempt to conserve their habitats and hope that most species living there will continue to thrive.

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Butterflies

Lepidoptera - Order of insects that includes butterflies and moths. They can be distinguished from all other insects by their two pairs of scale-covered wings, which are often brightly coloured, particularly in many butterflies. Lepidopterans undergo complete metamorphosis: eggs are laid, from which larvae hatch, and a pupal stage follows, during which the final adult form takes shape. Butterflies are slender-bodied (mostly) diurnal insects.

Quick facts

- Butterflies represent one small branch of the lepidopterans, representing about 10% of known species (the others are moth species). Globally, there are about 18 000 butterfly species. Canada is home to 302 resident species of butterflies, although only five are endemic.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (82%) of butterflies in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 9% have Canada ranks of Sensitive, 7% have Canada ranks of May Be At Risk and 2% have Canada ranks of At Risk.

- One butterfly species, the Frosted Elfin (*Callophrys irus*), is extirpated from Canada.

- Monarchs (*Danaus plexippus*) migrate thousands of kilometres to avoid the Canadian winter.

- The Cabbage White (*Pieris rapae*) and European Skipper (*Thymelicus lineola*) are the two exotic butterflies in Canada.

Canadian Tiger Swallowtail, *Papilio canadensis* © Rémi Hébert

Background

With their conspicuous daytime activity, bright colours, and jaunty flight patterns, butterflies tend to invoke the interest and sympathy of the general public. As a result, butterflies have become “flagship” invertebrates. That the Niagara Parks Butterfly Conservatory in Ontario attracted 850 000 visitors during its first full year of operation is one indicator of just how popular these insects have become.

Although butterflies number only about 10% of the order *Lepidoptera* – with moths comprising the other 90% – butterflies tend to be more eye-catching than moths, which are generally active during the night and are usually somewhat drab in colour. However, all butterflies begin life in a relatively understated form, as a tiny cryptic egg. A key to the survival of each generation lies in a female butterfly’s careful timing and choice of location for laying her eggs. Not only must she set the eggs on the right “host plant,” but she must also secure them to the right part of the plant, since not all plant parts will be equally edible to the caterpillar when it hatches from the egg. Upon hatching, the plant-chomping butterfly caterpillar grows by way of periodic moulting or shedding its skin. The last larval moulting results in the formation of a pupal case or chrysalis, rather than a larger caterpillar. This marks the start of a remarkable change, for, after a period of time, the pupal case splits open, and a fully formed adult winged butterfly emerges.

By undergoing total metamorphosis, butterfly larvae and adults are able to live radically different lifestyles in completely different environments – the former as a slow-crawling homebody with an insatiable appetite for vegetation, the latter as a flighty, wide-ranging sipper of nectar. Methodically munching through life, the larva exists in a tiny leafy world that contrasts greatly with that of the adult, which may be several hectares to several hundred square kilometres in extent. Indeed, Monarchs (*Danaus plexippus*) are known to undertake migratory flights of thousands of kilometres (adults tagged in Canada in the autumn have been subsequently recaptured in the winter forests of central Mexico). Most butterflies are relatively short-lived; entire cycle from egg to adult may be only a month or two, and adults may live only a week. Many species produce only one generation per year and fly only a few months out of the year.

Throughout most of Canada, where temperatures drop below freezing during part of the winter, at least one stage in a butterfly species' life cycle must enter a dormant state termed "diapause" in order to resist freezing. Most species that spend the winter months in Canada do so as caterpillars. Others pass the winter as eggs (e.g., hairstreaks) or pupae (elfins and other *Callophrys*), while a few species, mainly tortoiseshells (*Nymphalis*) and angelwings (*Polygonia*), spend the winter as adults, hibernating in holes in trees, crevices in rock, or other shelters, like buildings.

Science now recognizes about 18 000 butterfly species worldwide, and this great variety is thought to relate to the broad diversity of plant species, since larvae typically use only a relatively narrow range of food plants. The North American butterflies of the genus *Euphilotes*, for instance, feed only on members of the knotweed family (*Polygonaceae*); the larvae eat the flowers and fruits, and the adults sip the nectar.

Status of knowledge

Butterflies are a relatively well studied insect group in Canada thanks in large part to the many professional and amateur specialists who have taken an interest in these unique insects. The considerable number of butterfly articles and books documenting Canadian species are complemented by numerous collections including the Lyman Entomological Museum (Macdonald Campus of

McGill University in Montreal), the Royal Saskatchewan Museum of Natural History in Regina and the section on lepidopterans of the Canadian National Collection of insects in Ottawa. A recent publication by Peter W. Hall (2009) on behalf of NatureServe Canada, *Sentinels on the Wing: The Status and Conservation of Butterflies in Canada*, provides a comprehensive overview of the status of butterflies in Canada. This publication took into account the data and analyses from several organizations, including the general status results for butterflies developed by the National General Status Working Group and found in this report.

Richness and diversity in Canada

Within Canada, 302 butterfly species are described from coast to coast to coast, with the highest species richness found in the provinces from British Columbia through to Quebec. While many Canadian species are widespread, with the potential to be found in almost any province or territory (for example, Painted Lady - *Vanessa cardui*, Mourning Cloak - *Nymphalis antiopa*, Canadian Tiger Swallowtail - *Papilio canadensis*), a few species appear to be highly restricted in their distribution. For example, although further survey work may eventually describe a more extensive distribution for the species, Johansen's Sulphur (*Colias johanseni*) has only been found on a single hillside near Bernard Harbour in Nunavut and in a coastal area near Coppermine. There are two species of Exotic butterflies in Canada. One of them, the European Skipper (*Thymelicus lineola*) arrived in Ontario in about 1910. Spreading south and west, this species has today become a major pest of Common Timothy (*Phleum pratense*). Still more "successful" is the now familiar Cabbage White (*Pieris rapae*), introduced at Quebec City in about 1860 and now found throughout most of North America.

Species spotlight - Maritime Ringlet

The Maritime Ringlet (*Coenonympha nipisiquit*) lives exclusively in salt marsh habitats in the Chaleur Bay region of Canada's east coast. It has been found at only six sites. Population size and densities of the Maritime Ringlet are at their highest in habitats where there are large numbers of the host plant of the larva (salt meadow grass) and the source of nectar for the butterfly (sea lavender).

The average wingspan for males is 3.4 cm and 3.6 cm for females. An eyespot is present on about 33% of the males and is more common and better developed in females. Both males and females demonstrate ochre, grey and cream colour patterns. Males tend to darken as they age.

Flooding due to high tides and storm tides threaten all life stages of the Maritime Ringlet. Ice pushed onto their marshland habitats during winter storms can crush the overwintering larvae. The development and draining of marshland habitat are other significant threats. Researchers suspect there are likely other threats that have yet to be identified as there are numerous examples of ideal marshland habitats without populations of the butterfly.

The Maritime Ringlet has a Canada General Status Rank (Canada Rank) of At Risk and was designated Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in April 2009.

Species spotlight - Monarch

The Monarch (*Danaus plexippus*) is likely the most recognized of all North American butterflies. Its bright orange wings which span upwards of 93 to 105 mm display a thick black border with two rows of white spots. Additional markings include two highly visible black patches on the hind wings which are found only on males.

The monarch is widely distributed across North America, from southern Canada southwards to Central America, and from the Pacific to the Atlantic coasts. Within Canada, the monarch has been recorded in all ten provinces and in the Northwest Territories. In general, two breeding populations of the Monarch are recognized: western and eastern, with the Rocky Mountains being the dividing point. Each of the two populations has a distinct migratory pattern. Those easts of the Rockies are overwintering in Central Mexico, while those wests of the Rockies are overwintering in California.

Monarchs are wide-ranging and powerful fliers. In the fall, they migrate thousands of kilometres, travelling from Canada to Mexico and California. In Canada, the migrations are best observed in southern Ontario, particularly in Point Pelee National Park and Presqu’île Provincial Park. Monarchs conserve energy during migration by riding currents of rising warm air and will reach altitudes of over one kilometre in order to take advantage of the prevailing winds.

Monarchs can thrive wherever milkweeds grow, as the larvae (caterpillars) feed exclusively on milkweed leaves. As long as there are healthy milkweed plants, Monarchs will put up with high levels of human disruption and have been known to breed along busy highways and city gardens.

Threats to Monarch populations include environmental conditions such as violent storms, loss of breeding habitat and contaminants such as herbicides (which kills both the milkweed needed by the caterpillars and the nectar-producing wildflowers needed by the adults). A very large threat is the loss of overwintering habitats in Mexico and California. The Monarch has a Canada General Status Rank (Canada Rank) of Sensitive and was designated Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in November 2001.

Results of general status assessment

The report *Wild Species* 2010 marks the second national assessment for butterflies. On the 302 species of butterflies present in Canada, the majority have Canada ranks of Secure (217 species, 72%, figure 20 and table 27). Also, 24 species have Canada ranks of Sensitive (8%), 19 species have Canada ranks of May Be At Risk (6%) and four species are At Risk (2%). One butterfly species, the Frosted Elfin (*Callophrys irus*), is extirpated from Canada.

Eleven species of butterfly have Canada ranks of Undetermined or Not Assessed (3%). Two species are ranked as Exotic (1%). Finally, a higher number of species (24) have Canada ranks of Accidental (8%), due to the greater mobility of butterflies than some other taxonomic groups.

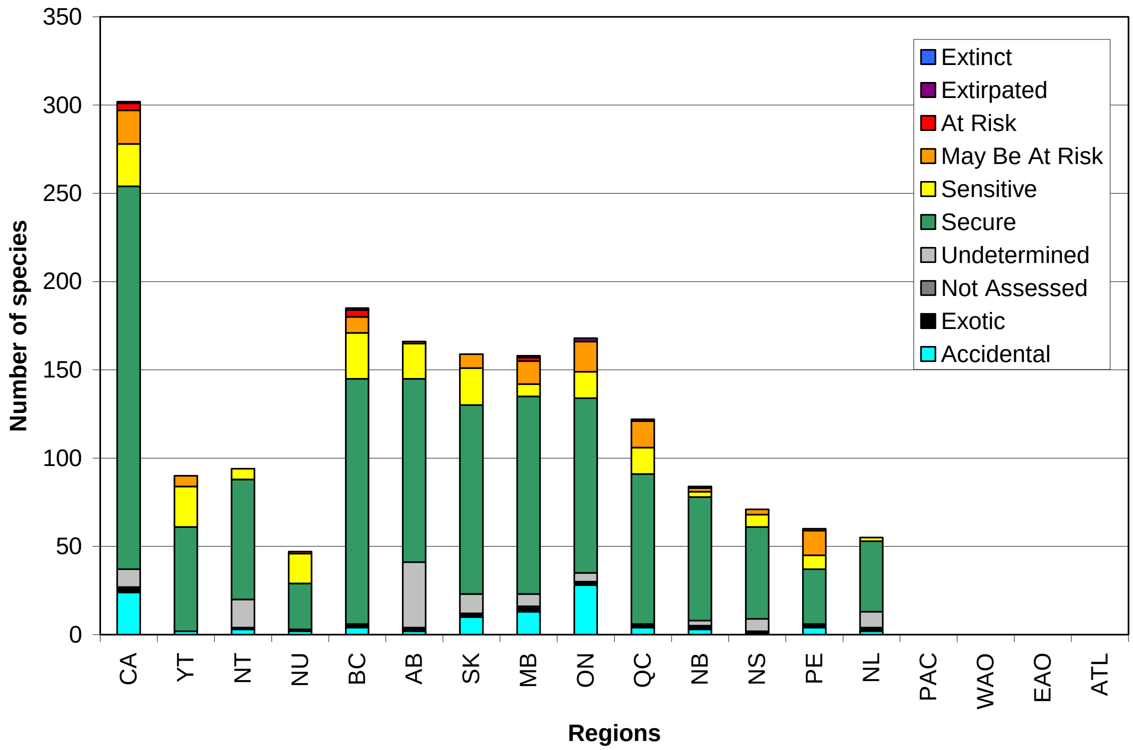

Figure 20. Results of the general status assessments for butterfly species in Canada in the *Wild Species* 2010 report.

Comparison with previous Wild Species reports

In the report *Wild Species* 2000, all butterfly species received a Canada Rank of Not Assessed. In 2002, the National General Status Working Group produced updated general status ranks for all wild species of butterflies, including Canada ranks. In 2002, assessments were based on the taxonomy of Layberry *et al*. (1998). In this report, *Wild Species* 2010, the taxonomy is very similar to that used in 2002, except for a few changes to bring the species list into accordance with that proposed by Pelham (2008).

In general, the 2010 assessment resulted in fewer species that were identified as May Be At Risk or Sensitive and an increase in the number of species ranked as Secure (table 27). A total of 32 species had a change in their Canada rank since the last assessment. Among these changes, three species had an increased level of risk, 13 species had a reduced level of risk, three species were changed from or to the ranks Undetermined or Accidental, 11 species were added and two species were deleted. In most cases, this is not an indication of a biological change, but of an increase in knowledge or of a taxonomic change (table 28). A total of nine species were added since the assessment of 2000 updated in 2002.

Table 27. Changes in the number of butterfly species over time in each rank category as determined by the National General Status Working Group. The analyses for the year 2000 include the database updated in 2002 for the butterflies.

	Canada rank	Years of the *Wild Species* reports			Average change between reports	Total change since first report
		2000	2005	2010		
0	Extinct / Extirpated	1 (0%)	-	1 (0%)	-	Stable
1	At Risk	2 (0%)	-	4 (2%)	-	+2 species
2	May Be At Risk	23 (8%)	-	19 (6%)	-	-4 species
3	Sensitive	31 (11%)	-	24 (8%)	-	-7 species
4	Secure	201 (69%)	-	217 (72%)	-	+16 species
5	Undetermined	11 (4%)	-	10 (3%)	-	-1 species
6	Not Assessed	0 (0%)	-	1 (0%)	-	+1 species
7	Exotic	2 (0%)	-	2 (1%)	-	Stable
8	Accidental	22 (8%)	-	24 (8%)	-	+2 species
	TOTAL	293 (100%)	-	302 (100%)	-	+9 species

Table 28. Reasons for changes in the status of butterfly species between the last assessment and the current report. The analyses for the year 2000 include the database updated in 2002 for the butterflies.

Scientific name	English name	2000 Canada rank	2010 Canada rank	Reason for change
Anthocharis stella	Stella Orangetip	4	-	(T) Taxonomic change.
Apodemia mormo	Mormon Metalmark	3	1	(C) Change due to new COSEWIC assessment (Endangered, May 2003).
Asterocampa celtis	Hackberry Emperor	2	3	(I) Improved knowledge of the species.
Battus philenor	Pipevine Swallowtail	5	8	(I) Improved knowledge of the species.
Callophrys gryneus	Juniper Hairstreak	2	4	(T) Taxonomic change.
Callophrys gryneus gryneus	Olive Juniper Hairstreak	-	2	(T) Taxonomic change.
Callophrys gryneus siva	Siva Juniper Hairstreak	-	4	(T) Taxonomic change.
Celastrina lucia	Northern Spring Azure	-	4	(T) Taxonomic change; was previously included in *Celastrina echo*.
Celastrina serotina	Cherry Gall Azure	5	4	(I) Improved knowledge of the species.
Colias occidentalis	Western Sulphur	3	4	(T) Taxonomic change.
Erebia lafontainei	Reddish Alpine	3	4	(T) Taxonomic change.
Erebia mackinleyensis	Mt. Mckinley Alpine	3	4	(T) Taxonomic change.
Erebia pawloskii	Yellow Dotted Alpine	3	4	(T) Taxonomic change.
Erebia youngi	Four-dotted Alpine	3	4	(T) Taxonomic change.
Erora laeta	Early Hairstreak	2	3	(I) Improved knowledge of the species.

Erynnis baptisiae	Wild Indigo Duskywing	2	3	(B) This species has been expanding its range.
Erynnis martialis	Mottled Duskywing	5	4	(I) Improved knowledge of the species.
Euphydryas anicia	Anicia Checkerspot	-	4	(T) Taxonomic change.
Euphydryas chalcedona	Variable Checkerspot	4	-	(T) Taxonomic change.
Euphydryas colon colon	Colon Checkerspot	-	4	(T) Taxonomic change.
Euphydryas colon paradoxa	Contrary Checkerspot	-	4	(T) Taxonomic change.
Euphyes dion	Dion Skipper	3	4	(I) Improved knowledge of the species.
Hesperia colorado	Western Branded Skipper	2	4	(T) Taxonomic change.
Lerema accius	Clouded Skipper	-	8	(I) New species in Canada.
Megathymus streckeri	Strecker's Giant Skipper	-	5	(I) New species in Canada.
Oeneis philipi	Philip's Arctic	3	4	(T) Taxonomic change.
Plebejus idas	Northern Blue	-	4	(T) Taxonomic change.
Poanes zabulon	Zabulon Skipper	-	5	(I) New species in Canada, but unsure if a population exists or whether it is purely a vagrant.
Polites sabuleti	Sandhill Skipper	3	2	(T) Taxonomic change.
Satyrium caryaevora	Hickory Hairstreak	3	4	(I) Improved knowledge of the species.
Satyrium semiluna	Sooty Hairstreak	2	1	(C) Change due to new COSEWIC assessment (Endangered, April 2006).
Speyeria egleis	Great Basin Fritillary	-	6	(T) Taxonomic change.

Threats to Canadian butterflies

Most experts agree that the modification and elimination of suitable habitat pose the greatest threat to native butterflies across the country. Butterflies associated with highly jeopardized natural communities, like the pine oak barrens and tallgrass prairies of Ontario and the Garry oak woodlands and the Okanagan and Silmilkameen valleys of British Columbia, are particularly susceptible.

Conclusion

Butterflies are flagship species and play an important role in the ecosystems. However, there is a need to better understand the threats that these species are facing. Since the 2002 updates to the *Wild Species* 2000 ranks for butterflies, two species were assigned a Canada Rank of At Risk (the result of COSEWIC assessments). The 2010 report presented the results of the second assessment of Canada ranks for butterflies by the National General Status Working Group, and this process will hopefully help to gather more information on the ecology of these species.

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Crustaceans

There are an estimated number of over 3000 species of crustaceans present in Canada. In this report, only one group of crustaceans, the crayfishes, are assessed.

Crayfishes

Astacoidea - Freshwater crayfishes are a globally common and diverse crustacean group, occurring naturally on all continents except for Africa and Antarctica

Quick facts

- There are more than 540 species of crayfishes worldwide, of which 11 are found in Canada.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (78%) of crayfishes in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 22% have Canada ranks of Sensitive.

- Two crayfish species have Canada ranks of Exotic, the Rusty Crayfish (*Orconectes rusticus*) and the Obscure Crayfish (*Orconectes obscurus*). Both were introduced into Ontario as fish bait and now also occur in Quebec. The Rusty Crayfish has spread rapidly in Ontario and has eliminated native crayfishes from many lakes and rivers. Little is known about the Obscure Crayfish in Canada.

- One-third of native crayfish species in the United States are Endangered or Threatened, according to the American Fisheries Society Endangered Species Committee.

Virile Crayfish, *Orconectes virilis* © Casey Swecker

Background

Crayfishes belong to the subphylum *Crustacea*, together with the crabs, lobsters and shrimps. All crayfishes have a jointed exoskeleton and breathe with gills. Canada's crayfishes are found in an amazing variety of freshwater habitats including wetlands, wet meadows, stagnant water, ponds, ditches, streams, rivers and lakes. Although all of Canada's crayfishes are also found in the United States, some Canadian populations show unique life history and ecology patterns compared to more southerly populations. There are two families of crayfishes in Canada, *Astacidae* and *Cambaridae*. *Astacidae* is represented by one species, the Signal Crayfish (*Pacifastacus leniusculus*), found in British Columbia. The other 10 species of crayfishes found in Canada all belong to the family *Cambaridae*.

The crayfishes' most noticeable feature is the large claws, found on the first of their five pairs of legs. These large claws, also called giant chelipeds, are used in feeding, mating, defence and burrowing. The other four pairs of legs are used for walking and searching for food. Although crayfishes usually walk slowly across the bottom of streams, rivers and lakes, they can escape from predators by flicking their strong tail and zooming backwards out of danger. On the front of their head, crayfishes have a pair of compound eyes, on short, flexible stalks. Crayfishes cannot turn their heads around, but the flexible stalks allow them to see in different directions. Crayfishes also have a pair of long antennae, which are used to sense food and chemicals in the water.

Crayfishes typically live for only a few years, so they must reproduce rapidly and at a high volume to maintain their populations. Most species mate during the fall or early spring. During mating, the male crayfish deposits his sperm in a sperm receptacle on the underside of the female. The female stores the sperm until she is ready to fertilize her eggs in the spring. When she is ready to lay her eggs, the female creates a pocket by curling her tail underneath her abdomen. This pocket is filled with a sticky substance, called glair, which will hold the eggs in place. As eggs are laid, they pass through the sperm receptacle and then down into the glair, where they remain until they are ready to hatch. Once hatched, the young crayfish remain attached to their mother for several weeks, until they have moulted twice. Finally, the young crayfish leave the mother to fend for themselves. In some species, crayfishes are ready to mate within a few months of hatching, whereas other species can take several years to mature.

Crayfishes can be divided into two major types: open-water species and burrowers. Open-water crayfishes rarely or never leave the water and are mainly active at night. During the day, they hide in crevices under rocks or other cover, to escape predation. Burrowers are less dependent on aquatic habitats than open-water species. They live in ditches, wet meadows and other areas where the water table is not far belowground. Burrowers dig tunnels under the ground and live in the moist soil, probably only emerging to hunt for food and to mate. Like other crayfishes, burrowers breathe with gills, but they are able to extract oxygen from moist air as well as from water.

Crayfishes have a diverse diet of aquatic and terrestrial vegetation, dead and decaying plant and animal material, and small aquatic invertebrates. By eating dead and decaying plant and animal matter, crayfishes release trapped energy and nutrients back into the food chain, where they are available to crayfish predators. This makes crayfishes an important link in aquatic food webs. Crayfishes are eaten by a wide range of animals including invertebrates, fishes, amphibians, reptiles, birds and mammals. They can also be an important food item for sport fishes, such as sunfishes and basses (family *Centrarchidae*).

Status of knowledge

Crayfishes are often used as study animals in laboratory experiments and classrooms because they are easy to obtain and maintain, so their basic biology is fairly well known. However, much less is known about crayfishes in the wild. In Ontario, several life history studies have been conducted on native and exotic species, but life history has not been studied extensively in other areas of the country. Similarly, their distribution is fairly well known in Ontario but less well known in the rest of the country. In particular, distributions at the northern edges of crayfishes' ranges and in areas where exotic species have been introduced need further research. Recent studies are starting to address these information gaps. For example, a recent study in British Columbia showed that the distribution of the Signal Crayfish is much larger than previously thought.

One of the leading concerns of crayfish biologists is the impact of introduced crayfishes on native communities. There are two species of crayfish that have Canada ranks of Exotic; the Rusty Crayfish (*Orconectes rusticus*) and the Obscure Crayfish (*Orconectes obscurus*), both of which were probably introduced to Canada as fish bait. The Rusty Crayfish has spread rapidly in Ontario and Quebec. It is a large, aggressive crayfish that can exclude native crayfishes such as the Northern Clearwater Crayfish (*Orconectes propinquus*) and the Virile Crayfish (*Orconectes virilis*) through aggressive interactions and higher reproduction rates. The Rusty Crayfish can also reduce the diversity and abundance of aquatic plants and invertebrates, compete with fish for food, and reduce fish reproduction by eating fish eggs. The Obscure Crayfish was also introduced into Ontario. Little is known about the Obscure Crayfish in Canada, but it is thought to exclude native crayfishes through competition. It is also believed to hybridize with Northern Clearwater Crayfish.

Crayfishes are used as biological indicators for several types of pollution. For example, in British Columbia, Signal Crayfish kept in cages at locations downstream of agricultural and residential land use areas showed increased levels of contaminant accumulation in their tissues. In Ontario, crayfishes have been used to study heavy metal contamination and acidification of lakes and streams.

Richness and diversity in Canada

Ontario (nine species) and Quebec (eight species) have the highest species richness of crayfishes in Canada (figure 21). Of the 11 Canadian crayfishes, the only two that do not occur in Ontario are the Spineycheek

Crayfish (*Orconectes limosus*), found in Quebec, New Brunswick and Nova Scotia, and the Signal Crayfish found in British Columbia. Two provinces (Newfoundland and Labrador and Prince Edward Island) as well as the three territories have no crayfishes.

Species spotlight - Chimney Crayfish

The Chimney or Digger Crayfish, *Fallicambarus fodiens*, (hereafter Chimney Crayfish) is one of two burrowing species found in Ontario. Chimney Crayfish live in wetlands, creek beds, ditches and in dry ground far from permanent surface water. To survive in these habitats, Chimney Crayfish dig burrows into the ground. Burrows usually consist of one to three entrance tunnels connecting with a vertical shaft. The shaft ends below the water table in a flooded chamber where the crayfish spends much of its day. The burrow entrance is marked by a pile (or chimney) of mud pellets, collected during excavation. Chimney Crayfish are thought to be omnivorous; they probably eat any vegetation or invertebrates encountered in their burrows.

Within Canada, Chimney Crayfish are found only in southern Ontario. Recent surveys found small populations as far north as south-eastern Georgian Bay and as far east as the northeast shore of Lake Scugog. This species seems to prefer to build its burrows in clay soil, so the thin soil and hard rock of the Canadian Shield may prevent it from expanding its range northwards. Although the Chimney Crayfish has a wide distribution within southern Ontario, it is never locally common and often lives in small habitat patches within a sea of agriculture or urban development. The highly developed nature of this region means that habitat loss is a major threat to the Chimney Crayfish.

Little is known about the life history of the Chimney Crayfish in Canada, but it is thought to breed in May and June and live for three to four years. Although further study into the life history of the Chimney Crayfish is needed, it has been suggested that Canadian populations have unique life history patterns, compared to more southerly populations.

Although the Chimney Crayfish is never locally common and is negatively impacted by habitat loss, there are many occurrences of this species in southern Ontario. Therefore Chimney Crayfish has a Canada General Status Rank (Canada rank) of Sensitive.

Species spotlight - Virile Crayfish

The Virile Crayfish, *Orconectes virilis*, is an open-water crayfish found from Alberta, east to New Brunswick, and is the most widely distributed crayfish in Canada. Although it is frequently found in rivers or streams with a rocky substrate, it is also found on mud or silt substrates, and in lakes. The Virile Crayfish spends the day sheltering in a shallow excavation under a rock. At night, it ventures out to feed on aquatic plants, algae and aquatic invertebrates.

The Virile Crayfish is widespread and common in most of its range. However, in Ontario and Quebec, the Virile Crayfish faces competition from the exotic Rusty Crayfish. The Rusty Crayfish, which is native to Ohio, Kentucky, Michigan and Indiana, has eliminated the Virile Crayfish from many aquatic systems in Ontario due to its superior competitive abilities and faster reproductive cycle. However, the Virile Crayfish is not likely to face immediate widespread population declines, as it still has many stable populations in areas where the Rusty Crayfish has not yet been introduced.

Several studies in Ontario have shown declining populations of Virile Crayfishes in lakes on the Canadian Shield. These population declines have been linked to acid rain, since increased acidity of the water can lead to reduced reproductive success in Virile Crayfishes. The situation is quite different in the western part of the Virile Crayfish's range. In Alberta, the Virile Crayfish is native to the Beaver River drainage, but has been introduced into other Alberta rivers, probably as fish bait. The rivers into which it has been introduced have no native crayfishes, so the Virile Crayfish faces little competition and has the potential to spread rapidly. Experiments have shown that the Virile Crayfish could alter aquatic systems in Alberta by reducing the abundance of native aquatic plants and invertebrates.

Although the Virile Crayfish is facing population declines and local extirpation in some parts of its range, it is a common, widespread species, with many occurrences in Canada. Therefore it has a Canada rank of Secure.

Results of general status assessment

Seven species (64%) of crayfishes have Canada ranks of Secure and two species (18%) have Canada ranks of Sensitive (figure 21 and table 29). In addition, two species (18%) of crayfishes have Canada ranks of Exotic.

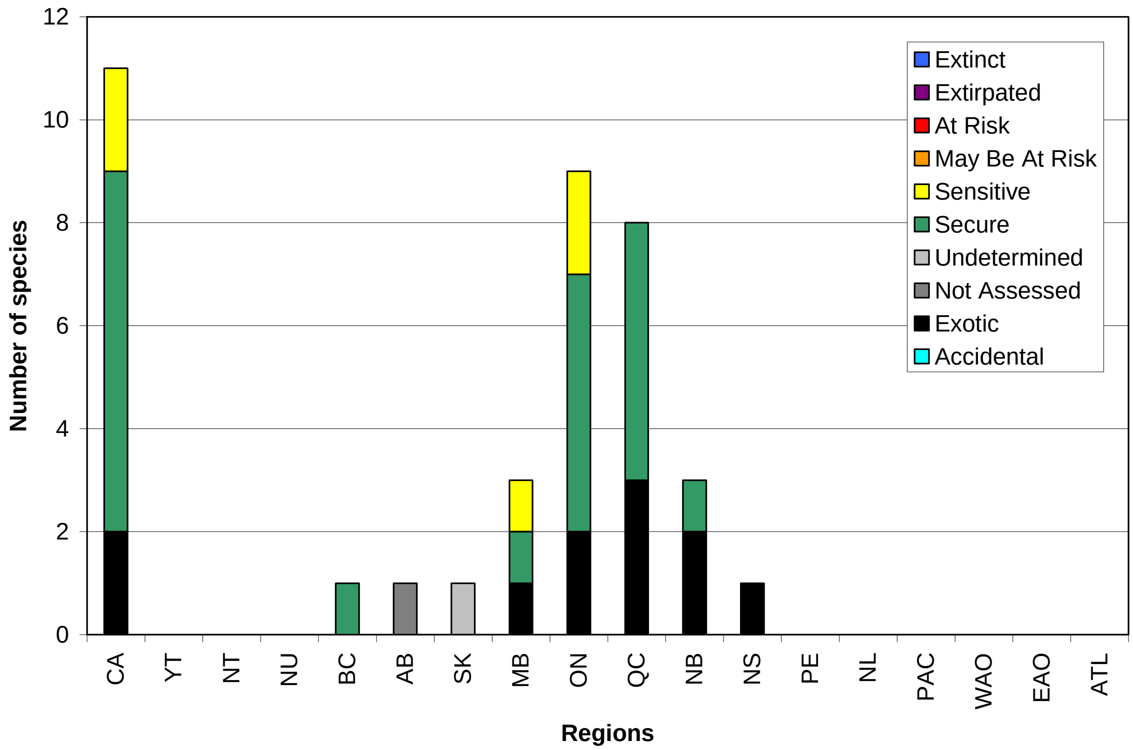

Figure 21. Results of the general status assessments for crayfish species in Canada in the *Wild Species* 2010 report.

Comparison with previous Wild Species reports

Even though some provincial ranks changed, the Canada ranks of crayfish species have not changed since the last assessment in 2005 (table 29).

Table 29. Changes in the number of crayfish species over time in each rank category as determined by the National General Status Working Group.

	Canada rank	Years of the *Wild Species* reports			Average change between reports	Total change since first report
		2000	2005	2010		
0	Extinct / Extirpated	-	0 (0%)	0 (0%)	-	Stable
1	At Risk	-	0 (0%)	0 (0%)	-	Stable
2	May Be At Risk	-	0 (0%)	0 (0%)	-	Stable
3	Sensitive	-	2 (18%)	2 (18%)	-	Stable
4	Secure	-	7 (64%)	7 (64%)	-	Stable
5	Undetermined	-	0 (0%)	0 (0%)	-	Stable
6	Not Assessed	-	0 (0%)	0 (0%)	-	Stable
7	Exotic	-	2 (18%)	2 (18%)	-	Stable
8	Accidental	-	0 (0%)	0 (0%)	-	Stable
	TOTAL	-	11 (100%)	11 (100%)	-	Stable

Threats to Canadian crayfishes

The two major threats to Canadian crayfishes are competition from exotic crayfishes and habitat loss. Exotic crayfishes have already caused local extirpation of native crayfishes in Ontario, but no native crayfishes are currently in danger of extirpation at a provincial or national level, due to the widespread distribution of the affected species. Habitat destruction due to damming and channelling, wetland loss, siltation and development of riparian habitat can all impact crayfishes. Habitat loss may have a greater impact on burrowing species, which occur in low densities in isolated habitat patches. In addition, air and water pollution, including acidification of lakes and rivers due to acid rain, can all impact crayfishes.

Conclusion

There remains much to be learned about Canadian crayfishes, including the limits of crayfish distribution, life histories in all regions of the country, and the impacts of introduced crayfishes on aquatic communities. Monitoring of crayfish populations, especially to document the spread of Exotic species, will be important in determining future status changes. Canada's crayfishes play an integral role in the freshwater systems in which they occur naturally and have the potential to alter systems into which they are introduced. Increasing our knowledge of crayfishes will help preserve healthy freshwater ecosystems throughout southern Canada.

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Amphibians

Amphibia - The class of vertebrate chordates that contains the frogs, toads, newts and salamanders. The amphibians evolved in the Devonian period (about 370 million years ago) as the first vertebrates to occupy the land, and many of their characteristics are adaptations to terrestrial life.

Quick facts

- There are roughly 5700 species of amphibians worldwide, 47 of which are found in Canada.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, more than two-thirds (67%) of amphibian species have Canada General Status Ranks (Canada ranks) of Secure, but 20% have Canada ranks of At Risk and 13% have Canada ranks of Sensitive. No amphibians have Canada ranks of May Be At Risk.

- Since *Wild Species* 2005, the Barred Tiger Salamander (*Ambystoma mavortium*) has been declared a separate species from the Eastern Tiger Salamander (*Ambystoma tigrinum*), increasing the total number of amphibian species in Canada to 47.

- On a global scale, many amphibian species are at a high level of risk of extinction; a recent Global Amphibian Assessment ranked nearly one-third (32%) of the world's amphibians as Threatened, compared with 23% of all mammal species and 12% of all bird species.

- The Wood Frog (*Lithobates sylvaticus*) has the most northerly distribution of any North American amphibian, and is the only North American amphibian found north of the Arctic Circle.

Great Plains Toad, *Anaxyrus cognatus* © Erik Enderson

Background

Canadian amphibians include frogs, toads, newts and salamanders. These cold-blooded vertebrates can be recognized by their soft, moist skin, without scales, feathers or fur. Many amphibians spend the first part of their life cycle as aquatic, gill-breathing larvae (also known as tadpoles) before they metamorphose into terrestrial, air-breathing adults. This dual life cycle allowed ancestral amphibians to be the first vertebrates to inhabit dry land more than 300 million years ago, giving rise to the modern amphibians, reptiles, birds and mammals.

Many people are familiar with the typical life cycle of frogs and toads, in which an aquatic larva with gills metamorphoses into a terrestrial air-breathing adult. However, in the process of adapting to a wide range of habitats, amphibians have developed a variety of different life cycles, ranging from completely aquatic (e.g. Mudpuppy, *Necturus maculosus*), to completely terrestrial. For example, the Northern Red-backed Salamander (*Plethodon cinereus*) lays its eggs on land and guards them until they hatch into juveniles, which look and behave much like the adults. Newts, such as the Roughskin Newt (*Taricha granulosa*) of British Columbia, have an additional stage in their life cycle, known as the eft. Aquatic larvae with gills metamorphose into terrestrial air-breathing efts, which live up to four years in moist terrestrial habitats. Efts must then metamorphose into amphibious adults to breed and complete the life cycle. The amazing diversity of life cycles displayed by amphibians is not matched in any other group of vertebrates.

Unlike reptiles, birds and mammals, adult amphibians do not have waterproof skin. This is advantageous for amphibians because it allows them to breathe through their skin as well as through their lungs, but it makes amphibians prone to dehydration. So how do amphibians survive on dry land? Many amphibians have special skin on their underside through which they can absorb moisture. This allows them to re-hydrate simply by sitting on moist soil or in a small puddle. To reduce water loss, many amphibians are nocturnal. During the day they remain under logs and rocks. At night, when the air is cooler and less evaporation occurs, they emerge to hunt for food or mates. These physical and behavioural adaptations allow amphibians to survive away from the water, where they can take advantage of many different habitats and food sources.

Like reptiles, amphibians are cold-blooded (ectothermic), meaning they rely on external heat sources (like the sun) to warm their body, rather than producing heat from food energy, like birds and mammals. However, amphibians can survive much further north than reptiles. The distribution of amphibians in northern habitats is largely related to winter temperature and the ability of individual species to tolerate cold. The champion of cold-tolerant amphibians is the Wood Frog (*Lithobates sylvaticus*), the only North American amphibian or reptile found north of the Arctic Circle. Wood Frogs survive cold temperatures by hibernating frozen underground for several months of the year. Normally cells rupture and die when they are frozen, but Wood Frogs produce a special “anti-freeze” chemical called a cryoprotectant that protects their cells when frozen solid! Cryoprotectants are of great interest to scientists, who have studied Wood Frogs to develop new methods of freezing mammalian organs, so they can be stored before transplantation.

Status of knowledge

People have been studying amphibians for centuries, so the basic biology, physiology and developmental biology of many species, particularly the frogs, is well known. The natural history of most amphibians in Canada is also generally well understood, but the distribution, population size and population structure of amphibians in some regions is not well known. This is partly due to the difficulties in monitoring amphibians which can include their nocturnal and secretive behaviours, their small size and their cryptic appearance. Initiatives such as “Frogwatch”, a program that uses volunteers to monitor amphibian populations across the country, are providing data which will increase our understanding of amphibian distributions, and provide baseline data to monitor population changes.

Genetic tools are becoming increasingly important in amphibian research. For example, in 1997, genetic analysis was used to distinguish the Oregon Spotted Frog (*Rana pretiosa*) as a separate species from the Columbia Spotted Frog (*Rana luteiventris*). Genetic tools have also been used to study American Bullfrog (*Lithobates catesbeianus*) dispersal in Ontario, the impact of clear-cutting on the Coastal Giant Salamander (*Dicamptodon tenebrosus*) in British Columbia and the evolution of new species of salamanders (speciation) in the Rocky Mountains.

In recent years, the impacts of environmental contaminants on the growth and development of amphibians has been studied across Canada. Chemicals and fertilizers, which collect in some aquatic habitats used by amphibians, can cause a range of negative effects including deformities, reduced immune system activity, abnormal behaviours and, in extreme cases, death. However, it is difficult to link these impacts with population declines.

Richness and diversity in Canada

Canada has 47 species of amphibians including one mudpuppy, two newts, seven toads, 18 frogs and 19 salamanders. The most species rich provinces are Ontario (26 species), British Columbia (22 species) and Quebec (21 species) (figure 22). British Columbia has the most species found nowhere else in Canada (13 species). All the amphibian species found in Canada are also found in the USA, but several species including the Canadian Toad (*Anaxyrus hemiophrys*) and the Mink Frog (*Lithobates septentrionalis*), have the majority of their range in Canada.

Species spotlight - Northern Leopard Frog

Northern Leopard Frogs, *Lithobates pipiens*, (Canada General Status Rank (Canada rank): Secure) are found in every province and territory except the Yukon. This medium-sized frog breeds in shallow, warm ponds and produces egg masses of 600 to 7000 eggs. Eggs hatch into tadpoles, which graze on algae for about 9 to 12 weeks, until they are ready to metamorphose into adults.

Adults spend the summer feeding away from the water, but return to deep, well-oxygenated water to hibernate.

Northern Leopard Frogs were once common throughout their Canadian range, but during the late 1970s they underwent rapid, widespread population declines in British Columbia, Alberta, Saskatchewan, and Manitoba. In fact, Northern Leopard Frogs had virtually disappeared from Manitoba by 1976 and from Alberta by 1979. Lack of monitoring before this period makes population trends difficult to interpret, and scientists are still uncertain of the reason for the declines. Since the 1980s, Northern Leopard Frog populations in Alberta and Saskatchewan have been recovering slowly, whereas Manitoba's populations have recovered relatively quickly. In British Columbia, populations have not substantially recovered and are now restricted to a single Wildlife Management Area.

The story of the Northern Leopard Frog demonstrates that even widespread, numerous species are vulnerable to catastrophic population declines and local extirpation. Scientists are now focusing on captive breeding and release in Alberta and British Columbia and population monitoring in Alberta and Saskatchewan to attempt to restore this species to its former range and to improve our knowledge of the Northern Leopard Frog.

Northern Leopard Frog, *Lithobates pipiens* © Erik Enderson

Species spotlight - Oregon Spotted Frog

The Oregon Spotted Frog, *Rana pretiosa*, was described as a distinct species, separate from the Columbia Spotted Frog, in 1997. In the same year, the Oregon Spotted Frog was the first species to be given an emergency listing of Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This small frog was once distributed from southwest British Columbia to northwest California, but is now restricted to small, isolated populations and is estimated to have been lost from more than 90% of its historic range. Population declines and range reduction have been linked to habitat loss, changes in hydrology, introduction of exotic predators and vegetation, and isolation of remaining populations. In addition, they are vulnerable to pollution and climate change. Now known from only three populations in southwest British Columbia and less than 30 populations in the United States, this species has a Canada rank of At Risk, and an IUCN Red List rank of Vulnerable, meaning it is considered vulnerable to extinction on a global scale.

Since the emergency designation by COSEWIC, work has begun on a recovery plan for the Oregon Spotted Frog with the co-operation of government agencies, universities, local native groups and the public. Captive breeding, habitat mapping and habitat remediation have already begun. Although the three small remaining Canadian populations are isolated from each other and from populations in the United States, the development of the recovery plan and the co- operation between different agencies and groups gives hope that this species can be preserved into the future.

Species spotlight - Western Toad

The Western Toad, *Anaxyrus boreas*, is the only toad found in the Yukon, and it is also found in the Northwest Territories, British Columbia and Alberta. This large toad breeds in the shallow margins of ponds, streams and lakes. Females can produce clutches of up to 15 000 eggs, but may breed only once in their lifetime. Adult toads frequently wander long distances from water and are usually nocturnal, especially at low elevations. In the winter, Western Toads hibernate in animal burrows or under loose debris. Adult Western Toads are carnivorous and eat a wide range of invertebrates including earthworms, beetles, spiders and ants. Despite their ability to release a mild poison, Western Toads are preyed on by reptiles, mammals and birds.

Due to a COSEWIC status assessment (Special Concern in 2002), the Canada rank of the Western Toad changed from Secure in *Wild Species* 2000 to

Sensitive in *Wild Species* 2005. The Canada rank remains Sensitive in this report. The 2002 COSEWIC status assessment found this species of special concern, due to evidence of population declines and at least one example of a local extirpation. Canadian populations of Western Toads are not only a unique component of the fauna of western Canada, they are also important to the global survival of this species, due to declining populations in the United States. Careful monitoring and research are needed to help maintain healthy Canadian populations of Western Toads.

Results of general status assessment

Of the 47 species of amphibians found in Canada, nine species (19%) have Canada ranks of At Risk (figure 22). Within Canada, all nine species with Canada ranks of At Risk have fairly restricted ranges. None are found in the territories, and only one, the Allegheny Mountain Dusky Salamander (*Desmognathus ochrophaeus*), is found in more than one province (Ontario and Quebec).

Six species of amphibian have Canada ranks of Sensitive (13%) and 31 species have Canada ranks of Secure (66%). Canada has no Exotic or Accidental amphibian species and no species have Canada ranks of May Be At Risk, Undetermined or Not Assessed.

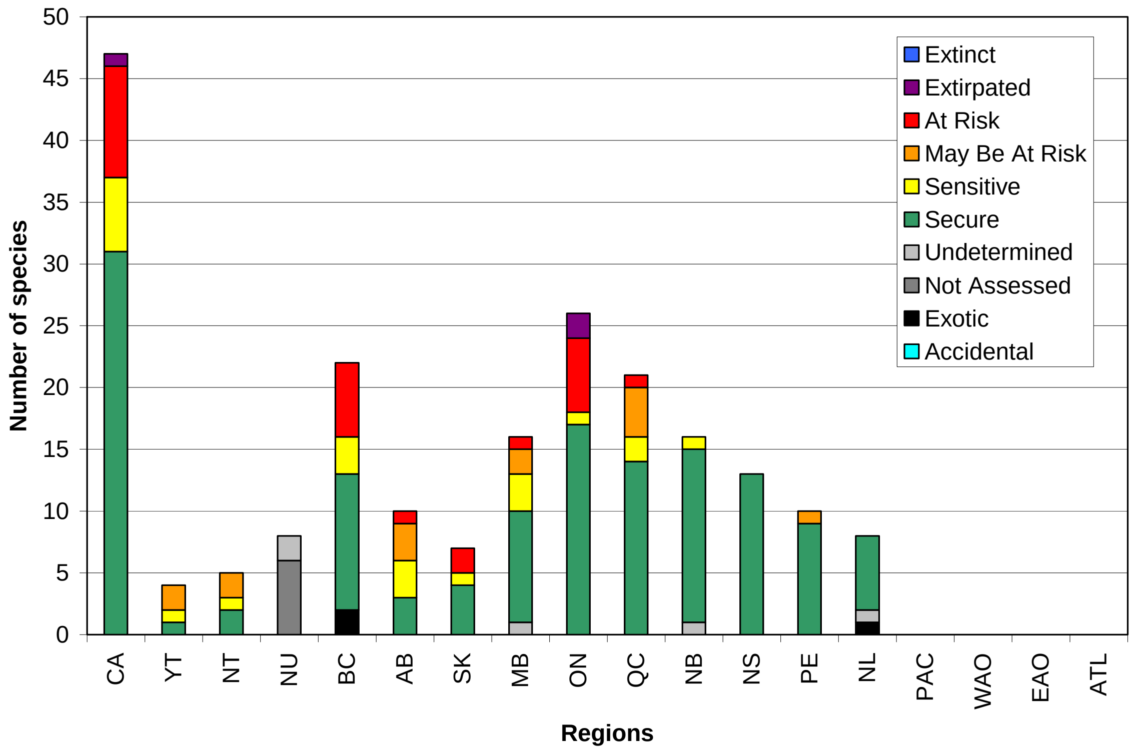

Figure 22. Results of the general status assessments for amphibian species in Canada in the *Wild Species* 2010 report.

Comparison with previous Wild Species reports

Since the report *Wild Species* 2005, the Barred Tiger Salamander (*Ambystoma mavortium*) is no longer considered a subspecies of the Eastern Tiger Salamander (*Ambystoma tigrinum*) and both salamanders are now treated as full species. This raised the total number of amphibians in Canada from 46 to 47 (table 30) and led to a Canada rank of Extirpated being assigned to the Eastern Tiger Salamander (based on 2001 COSEWIC assessment).

A total of three species had a change in their Canada rank since the last assessment. Among these changes, one species had an increased level of risk, one species had a reduced level of risk, and one species was added. The changes were due to taxonomic change and improved knowledge (table 31). None of the changes were due to biological changes in species abundance, distribution or threats.

Table 30. Changes in the number of amphibian species over time in each rank category as determined by the National General Status Working Group.

	Canada rank	Years of the *Wild Species* reports			Average change between reports	Total change since first report
		2000	2005	2010		
0	Extinct / Extirpated	0 (0%)	0 (0%)	1 (2%)	+1 species	+1 species
1	At Risk	4 (9%)	9 (20%)	9 (19%)	+3 species	+5 species
2	May Be At Risk	6 (13%)	0 (0%)	0 (0%)	-3 species	-6 species
3	Sensitive	6 (13%)	7 (15%)	6 (13%)	Stable	Stable
4	Secure	29 (64%)	30 (65%)	31 (66%)	+1 species	+2 species
5	Undetermined	0 (0%)	0 (0%)	0 (0%)	Stable	Stable
6	Not Assessed	0 (0%)	0 (0%)	0 (0%)	Stable	Stable
7	Exotic	0 (0%)	0 (0%)	0 (0%)	Stable	Stable
8	Accidental	0 (0%)	0 (0%)	0 (0%)	Stable	Stable
	TOTAL	45 (100%)	46 (100%)	47 (100%)	+1 species	+2 species

Table 31. Reasons for changes in the status of amphibian species between the last assessment and the current report.

Scientific name	English name	2005 Canada rank	2010 Canada rank	Reason for change
Ambystoma mavortium	Barred Tiger Salamander	-	4	(T) Previously included in *Ambystoma tigrinum* (taxonomic change).
Ambystoma tigrinum	Eastern Tiger Salamander	4	0.1	(T) Listed as Extirpated by COSEWIC in 2001. Previous General Status rank included subspecies *mavortium*, now treated as a full species.
Plethodon idahoensis	Coeur d'Alene Salamander	3	4	(I) Improved knowledge of the species.

Threats to Canadian amphibians

Global amphibian declines over the last 20 years, have spurred considerable discussion of threats to amphibians. Major threats include habitat loss and degradation, introduction of exotic species, over-harvesting (for commercial and recreational use), increases in UV radiation, pollution, disease and climate change. In addition, road mortality is also a threat to some amphibian populations.

Habitat loss is one of the leading threats to amphibians in Canada. In parts of southern Canada, 90% of wetlands have been drained or otherwise destroyed. Remaining wetlands within agricultural or urban landscapes may be polluted and often retain a reduced abundance and diversity of amphibians. In addition, fragmentation of remaining habitat can reduce or prevent the movement of individuals between populations, leading to reduced population stability and reduced flow of genes between populations.

Fungal and viral diseases have been implicated in some global amphibian declines, even in pristine habitats. Research is showing that disease acts on populations in combination with other stresses. For example, incidence of disease may be increased in populations stressed by other factors such as pollutants or increased UV-B radiation.

Conclusion

This reassessment of Canada's amphibians resulted in three Canada rank changes compared to *Wild Species* 2005. The changes resulted not from biological changes in species abundance, distribution or threats, but from taxonomic change, a COSEWIC assessment and improvements in our knowledge of Canadian amphibians.

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Reptiles

Reptilia - Class of vertebrates regrouping any cold-blooded scaly animals including snakes, lizards, crocodiles, turtles, tortoises, etc.

Quick facts

- There are more than 8000 species of reptiles worldwide, of which 48 species have been found in Canada. Of these, four species are found in marine habitats (sea turtles) and 44 species are found in freshwater and terrestrial habitats.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, only 33% of reptiles in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 42% have Canada ranks of At Risk and 25% have Canada ranks of Sensitive.

- Three species of reptiles are extirpated from Canada.

- Compared to *Wild Species* 2005, the Canada ranks of six reptile species have been altered. Of these, the ranks of four species moved into higher level of risk following new COSEWIC assessments, the rank of one species moved into a lower level of risk, and one species was added due to a taxonomic change.

- Since the report *Wild Species* 2000, the category At Risk had the highest increase in the number of species, while the Secure category had the highest decrease in the number of reptile species.

Wood Turtle, *Glyptemys insculpta* © John Mosesso Jr.

Background

A total of 48 species of reptiles has been found in Canada, including 26 snakes, seven lizards, 11 freshwater turtles and four marine turtles (over the past decade, there has been much scientific debate about the evolutionary relationships between turtles, lizards, snakes, crocodiles and birds leading to the suggestion that turtles should be considered in their own class, separate from the other reptiles. While some organizations have already adopted this approach, the general status program is currently taking the more conservative approach of keeping all turtles, snakes and lizards in their traditional class of *Reptilia*, until the scientific debate is clarified). This relatively small group is diverse, and contains species that live in habitats extending from belowground to the treetops, and from the depths of the oceans to the arid badlands. Reptiles can be most easily recognized by their dry scaly skin or, in the case of turtles, their hard, bony shell. Reptile scales are a continuous part of the skin and in some species are modified into unique forms, such as the spines and spikes of the Greater Short-horned Lizard (*Phrynosoma hernandesi*), and the nose scales that give the Eastern Hognosed Snake (*Heterodon platirhinos*) its name. All reptiles are cold-blooded, or ectothermic, meaning that instead of using food energy to generate body warmth (as mammals and birds do) they rely on external heat sources, such as the sun. In order to maintain a suitable internal temperature, many reptiles alternate between basking in the sun and hiding in the shade.

Reptiles are descended from amphibians, but unlike amphibians, reptiles have a waterproof skin and are not reliant on water or moist conditions for reproduction. This allowed reptiles to become the first completely terrestrial vertebrates, approximately 300 million years ago. One of the key adaptations that enabled reptiles to reproduce on dry land was the development of a complex egg with a leathery shell. The shell protects the embryo and prevents it from drying out, but is soft enough to expand as the embryo develops. Today, the majority of reptile species still lay eggs, but a few, such as the Northern Alligator Lizard (*Elgaria coerulea*), give birth to live young. This allows the mother to protect the developing young from extreme conditions of heat or cold, and from predators.

All of Canada’s terrestrial and freshwater reptiles hibernate to escape the long, cold winter, but different species have unique methods of surviving hibernation. Greater Short-horned Lizards simply bury themselves a few centimetres into the ground, often on a south-facing slope to take advantage of the sun’s warmth. Freshwater turtles, such as the Painted Turtle (*Chrysemys picta*) and the Blanding’s Turtle (*Emydoidea blandingii*), spend their winters deep underwater, where they are protected from the worst of the cold weather. In order to survive for several months without air, these turtles suck water into and out of their mouths, where specialized tissue in the throat exchanges oxygen and carbon dioxide with the water.

Reptiles sense the world very differently from humans and some even have additional sense organs to provide extra information about their environment. For example, many snakes and lizards use their tongue to detect chemicals in the air (equivalent to our sense of smell). As a snake’s tongue flickers in and out of its mouth, tiny airborne particles are collected and analysed by the Jacobson organ in the roof of the mouth. This system can be incredibly sensitive; a male Common Gartersnake (*Thamnophis sirtalis*) can tell the size and likely productivity of a female with a single flicker of his tongue, by detecting the pheromones she releases. Pit vipers, such as the Western Rattlesnake (*Crotalus oreganus*), have heat sensors concentrated in small pits between the nostril and the eye. These can detect temperature changes of less than 0.1°C, allowing the snake to detect warm-blooded prey, even in the dark. Marine turtles undergo vast migrations each year, and have a remarkable ability to return to specific locations such as nesting beaches or feeding grounds. To accomplish this navigational feat, marine turtles probably use a range of senses including sight and an ability to sense the earth’s magnetic field.

Status of knowledge

The status of knowledge of Canadian reptiles is highly variable between species. Although some reptile species have been well studied, many have not, and the distribution, population trends and life history of some Canadian reptiles remain poorly known. This is partly due to lack of baseline data and partly due to the difficulties of detecting reptiles, which are often solitary and secretive by nature.

Volunteer initiatives such as Nova Scotia Herpetofaunal Atlas and the Ontario Herpetofaunal Summary Atlas are collecting valuable information about the distribution and abundance of reptiles, as well as raising public awareness of this group. To date, COSEWIC has also assessed many species, subspecies and populations of reptiles, consolidating knowledge of species that are already suspected of being at risk.

Canada is home to one of the best studied snake populations in the world, the Red-sided Gartersnakes (*Thamnophis sirtalis parietalis*) of the Narcisse Wildlife Management Area in southern Manitoba. These snakes, a subspecies of the Common Gartersnake, hibernate in communal dens, called hibernacula. In southern Manitoba, good hibernacula sites are rare, so snakes crowd into the few available sites, where as many as 10 000 snakes spend the winter together. This large concentration of snakes has allowed researchers to study mating strategies, mating success, thermoregulatory behaviour and migration with relative ease.

In recent years, some Canadian reptile research has focused on species that are known to be declining. As well as providing information on reasons for declines, these studies can provide valuable information on the life history and distribution of Canadian reptiles. For example, recent studies on the Wood Turtle (*Glyptemys insculpta*, Canada General Status Rank (Canada rank): At Risk), have investigated life history and population size, impacts of agriculture on population recruitment and survival, habitat selection and genetics of isolated populations.

Most reptiles are represented in Canada by populations at the edge of the species’ geographic range. This offers opportunities to study factors that limit a species’ range and compare peripheral populations with those in the center of a species’ range. Another hot topic in Canadian reptile research is the thermal ecology of reptiles; how reptiles use different habitats to control their body temperature and the importance of this to their life history and fitness.

Richness and diversity in Canada

Terrestrial and freshwater reptiles are concentrated in southern Canada, with the highest species richness in Ontario (27 species), Quebec (19 species) and British Columbia (16 species) (figure 23). British Columbia has the highest number of species (nine) that have been found nowhere else in Canada. Two regions of Canada (Yukon, Newfoundland and Labrador) report no reptile species. All of Canada's reptiles are also found in the US, but several species, such as the Eastern Foxsnake (*Pantherophis gloydi*) and the Northern Alligator Lizard, have a large portion of their range in Canada.

Canada's four marine turtles are all found in the Atlantic or Pacific Oceanic regions; none have been found in Arctic waters, where conditions may be too extreme for reptiles to survive (figure 23).

Species spotlight - Leatherback Seaturtle

The Leatherback Seaturtle (*Dermochelys coriacea*), is the world's largest living reptile, reaching a length of 2 m and a weight of up to 900 kg! Leatherback Seaturtles live in the Atlantic, Pacific and Indian Oceans and nest on sandy beaches in warm tropical waters. Between breeding seasons, they migrate north and can be found off the east and west coasts of Canada in the Atlantic Ocean Region and the Pacific Ocean Region. The Leatherback Seaturtle is the only marine turtle without a hard shell. Instead its back is covered with a semi-flexible substance made of connective tissue and numerous tiny bones, allowing Leatherback Seaturtles to dive to much greater depths than other marine turtles. The favourite food of Leatherback Seaturtles is jellyfish and they have special backward pointing spines in their throat to help them swallow this slippery food. Global populations of Leatherback Seaturtles declined by approximately 70% between 1980 and 1995 and this species has a Canada rank of At Risk.

These amazing turtles are difficult to study because they spend very little time on land. After they have hatched, the females return to shore only to lay eggs and males never return to shore, making it difficult to study the distribution or migration patterns of these turtles. However, Canadian researchers, working off the coast of Nova Scotia, have pioneered a new method for studying Leatherback Seaturtles. Turtles are captured at sea, and a small satellite transmitter is attached to their shell, before they are released. This does not harm the turtles, and allows researchers to track their movements via satellite. Adult males, adult females and juveniles have been tracked in this manner, the first time that researchers have been able to follow the movements of male or juvenile Leatherback Seaturtles. The results of the study are quite incredible; adults and juveniles completed migrations of approximately 10 000 km from the cold waters off Nova Scotia, to the Caribbean Sea and adjacent areas of the Atlantic Ocean and back again, within a 12 month period. This study, and others like it, provides us with the information necessary to help conserve these giant reptiles.

Species spotlight - Greater Short-horned Lizard

Many Canadians are surprised to learn that seven different species of lizards have been found in Canada! One of the better known Canadian lizards is the Greater Short-horned Lizard, *Phrynosoma hernandesi*. Within Canada, these lizards are patchily distributed in mixed-grass prairie habitat in south-eastern Alberta and south-western Saskatchewan, where they favour sheltered, south-facing slopes. This slow-moving lizard has many potential predators, including hawks and other birds, snakes and mammals. When approached by a predator, the lizard freezes, and relies on its cryptic colouration to escape capture. Greater Short-horned Lizards eat ants, grasshoppers and other small invertebrates, using their excellent eyesight to locate their prey.

Greater Short-horned Lizards are at the very northern edge of their range in Canada. To escape from the cold winter, they hibernate under shallow soil on south-facing slopes. During the summer, these lizards conserve energy and heat by moving slowly, and spending much of their time on south-facing slopes. In addition, the females give birth to live young, allowing the mother to keep the eggs warm and safe from predators.

Greater Short-horned Lizards are patchily distributed in Canada, and most populations are small. Distribution and population size are greatly restricted by environmental variables, and increased grazing and development threaten their habitat. Greater Short-horned Lizards have a Canada rank of At Risk.

Results of general status assessment

Of Canada's 48 species of reptiles, only 28% (13 species) have a Canada rank of Secure, while a total of 35% have Canada ranks of At Risk (17 species, figure 23 and table 32). A further 21% have Canada ranks of Sensitive (10 species), 4% have Canada ranks of Exotic (two species), 4% have Canada ranks of Accidental (two species) and 2% have Canada ranks of Undetermined (one species). Finally, three terrestrial reptiles have Canada ranks of Extirpated (6%), none of which have been reported in Canada for at least 40 years.

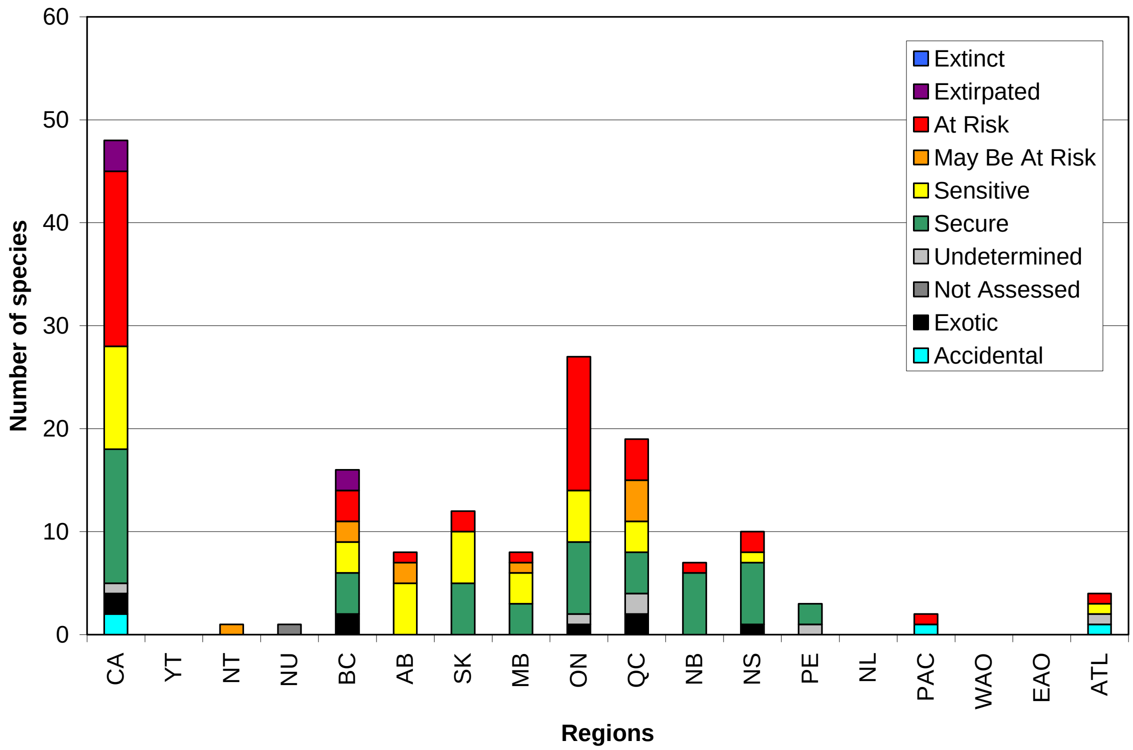

Figure 23. Results of the general status assessments for reptile species in Canada in the *Wild Species* 2010 report.

Comparison with previous Wild Species reports

Since the report *Wild Species* 2000, the category At Risk had the highest increase in the number of species, while the Secure category and the highest decrease in the number of reptile species (table 32).

With the revision of the ranks provided in this report, the Canada ranks of six reptile species have been altered compared to *Wild Species* 2005. Of these, the ranks of four species moved into higher level of risk following new COSEWIC assessments, the rank of one species moved into a lower level of risk, and one species was added due to a taxonomic change (table 33).

One species, the Prairie Rattlesnake (*Crotalus viridis*, Canada rank: Sensitive), has been added to the national species list since the report *Wild Species* 2005, bringing the total number of reptile species in Canada to 48. This addition was due a taxonomic change (split from the species Western Rattlesnake, *Crotalus oreganus*).

Table 32. Changes in the number of reptile species over time in each rank category as determined by the National General Status Working Group.

	Canada rank	Years of the *Wild Species* reports			Average change between reports	Total change since first report
		2000	2005	2010		
0	Extinct / Extirpated	0 (0%)	3 (6%)	3 (6%)	+2 species	+3 species
1	At Risk	10 (22%)	13 (28%)	17 (35%)	+4 species	+7 species
2	May Be At Risk	2 (4%)	2 (4%)	0 (0%)	-1 species	-2 species
3	Sensitive	12 (26%)	12 (26%)	10 (21%)	-1 species	-2 species
4	Secure	18 (40%)	12 (26%)	13 (28%)	-3 species	-5 species
5	Undetermined	1 (2%)	1 (2%)	1 (2%)	Stable	Stable
6	Not Assessed	0 (0%)	0 (0%)	0 (0%)	Stable	Stable
7	Exotic	1 (2%)	2 (4%)	2 (4%)	+1 species	+1 species
8	Accidental	2 (4%)	2 (4%)	2 (4%)	Stable	Stable
	TOTAL	46 (100%)	47 (100%)	48 (100%)	+1 species	+2 species

Table 33. Reasons for changes in the status of reptile species between the last assessment and the current report.

Scientific name	English name	2005 Canada rank	2010 Canada rank	Reason for change
Crotalus oreganus	Western Rattlesnake	3	1	(C) Listed as Threatened by COSEWIC in 2004.
Crotalus viridis	Prairie Rattlesnake	-	3	(T) Formerly combined with *Crotalus oreganus* (taxonomic change).
Emydoidea blandingii	Blanding's Turtle	2	1	(C) Listed as Endangered (Nova Scotia population) and Threatened (Great Lakes - St. Lawrence population) by COSEWIC in 2005.
Glyptemys insculpta	Wood Turtle	3	1	(C) Listed as Threatened by COSEWIC in 2007.
Phrynosoma hernandesi	Greater Short-horned Lizard	2	1	(C) Listed as Endangered by COSEWIC in 2007.
Pituophis catenifer	Gophersnake	3	4	(I) Improved knowledge of the species.

Threats to Canadian reptiles

The major threat to terrestrial and freshwater reptiles is habitat fragmentation and destruction. For example, populations of Prairie Skink (*Eumeces septentrionalis*) are thought to have declined as prairie habitat has been converted to agriculture and as habitat within protected areas has become fragmented by succession.

Road mortality is a serious threat to some reptile populations, especially for species that are long-lived and rely on high survival rates of adults to sustain their population. Reptiles may be attracted to roads as suitable basking spots, or as suitable nesting substrate, putting then in danger of being killed by passing cars. In addition, roads can create barriers that reptiles must cross to reach breeding or hibernating habitat. Finally, roads can fragment populations by preventing or reducing the number of individuals that move between populations.

Reptiles are popular pets around the world, and although ethical suppliers only sell animals bred and reared in captivity, reptiles are still taken from the wild to be sold as pets. Collecting animals in an unsustainable manner can lead to population declines, and adds an additional pressure to populations that may already be contending with habitat loss or other threats. Both the Exotic reptiles found in Canada were introduced into the wild by release of captive animals, and both species have the potential to compete with native reptiles. Other important threats to freshwater and terrestrial reptiles include exotic predators, pollution, disease, exploitation and human fear of reptiles.

Threats to marine reptiles include pollution and injuries and mortalities through contact with fishing equipment. In addition, some marine reptiles face habitat loss and over-exploitation through illegal harvest or poaching on their nesting beaches. Habitat restoration on nesting beaches can be hampered by sand removal.

Conclusion

This report shows that a total of 35% of reptile species have Canada ranks of At Risk in Canada, the highest proportion of any group covered in this report. *Wild Species* 2010 presents a more accurate report on the status of reptiles in Canada, than was available in 2000 and 2005 due to an increase in the amount and detail of information available about Canadian reptiles.

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Birds

Aves - Class of feathered, warm-blooded vertebrates, having a beak and wings, laying eggs and usually able to fly.

Quick facts

- There are approximately 10 000 species of birds worldwide, of which 664 have been found in Canada.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (78%) of birds in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 11% have Canada ranks of Sensitive, 8% have Canada ranks of At Risk and 3% have Canada ranks of May Be At Risk.

- Three species of birds that were present in Canada are now extinct from the World, the Labrador Duck (*Camptorhynchus labradorius*), the Great Auk (*Pinguinus impennis*) and the Passenger Pigeon (*Ectopistes migratorius*), and one species is extirpated from Canada, the Greater Prairie-Chicken (*Tympanuchus cupido*).

- Each spring, up to 3 billion birds of more than 300 species migrate north to breed in Canada’s boreal forest!

- Arctic Terns (*Sterna paradisaea*) make an annual migration from their breeding grounds in the Canadian Arctic to their Antarctic wintering grounds, a round-trip of approximately 35 000 km.

- Christmas Bird Counts have been used to survey North American birds since 1900. During the 2008-2009 count, 11 059 Canadian volunteers counted 2.84 million birds of 283 species.

- Since 2000, a total of 25 new bird species have been added to the national list. Most of these species have Canada ranks of Accidental, and many have been recorded from only one province or territory.

Red Knot, *Calidris canutus* © Raymond Belhumeur

Background

From the delicate Ruby-throated Hummingbird (*Archilochus colubris*) to the regal Great Blue Heron (*Ardea herodius*), birds are arguably the best known and most popular group of species covered in this report. Birds show incredible diversity of shape, size, behaviour and ecology, but are united by their adaptations for powered flight. These adaptations have shaped every aspect of the biology of birds, from the modification of forelimbs into wings, to the development of a highly efficient one-way breathing system.

Feathers are as unique to birds as hair is to mammals. Whether feathers originally evolved for use in flight, or to aid with insulating or cooling of the body (thermoregulation), is uncertain. However, in modern birds, feathers are used for a variety of purposes including the creation of a streamlined body shape, flight, insulation, and for display. In addition, many bird species have feathers that are specially adapted for particular purposes, such as producing sound during display flights (e.g. Wilson's Snipe, *Gallinago delicata*) and improving hearing. Owls, like the Barn Owl (*Tyto alba*), have a facial disc of stiff, dense feathers forming a concave surface that channels sound into their ears, enhancing their sensitive hearing and allowing them to accurately locate their prey by sound alone.

Flight gives birds the flexibility of moving over large distances to take advantage of different habitats and resources. Canadian winters are harsh and food is often in short supply, particularly for insect-eating birds, so every fall billions of birds migrate south to take advantage of warmer weather and more abundant food supplies. Most bird species migrating from Canada travel south to the United States, the Caribbean and South America while a very few make their way to Europe, Africa or Asia. Some seabird species show seasonal movements that reflect oceanic rather than continental patterns. Migrant species are diverse, ranging from tiny songbirds, such as the Blackpoll Warbler (*Dendroica striata*), to waterfowl like the Snow Goose (*Chen caerulescens*), seabirds like the Arctic Tern (*Sterna paradisaea*) and raptors like the Swainson's Hawk (*Buteo swainsoni*). The most spectacular group of migrants is probably the shorebirds. Some shorebirds, such as the Red Knot (*Calidris canutus*) regularly breed in the Arctic and migrate as far south as the southern tip of South America! Non-migratory birds, or birds that only move short distances, have adaptations to enable them to survive the winter. For instance, the Gray Jay (*Perisoreus canadensis*) and the Clark's Nutcracker (*Nucifraga columbiana*) both store food to help avoid shortages. The White-tailed Ptarmigan (*Lagopus leucura*), found in the Arctic, buries itself under the snow to keep warm at night and during snow storms.

Birds need a large, consistent food supply to fuel their warm-blooded metabolism. They use a wide variety of foods to meet this demand, including seeds, fruit, nectar, tree sap, insects, small reptiles, mammals and other birds. Because the forelimbs of birds are highly adapted to flight, their bills and talons are very important in feeding. The shape of a bird's bill can tell you much about its diet, from the large sturdy bill of seed-eating finches, to the hooked bill of hawks and owls. Even birds' tongues vary depending on what they eat. For example, the tongue of a Northern Flicker (*Colaptes auratus*) is sticky and very long – more than 12 cm from base to tip – to allow it to reach into anthills to extract the ants on which it feeds.

For centuries people have been inspired by the beautiful songs of birds like the Winter Wren (*Troglodytes troglodytes*) and the Hermit Thrush (*Catharus guttatus*). Male birds typically use song both to attract a mate (courtship) and to defend their territory from other males. Although song is one of the most important ways that birds attract a mate, it is by no means the only one. For example, many species of duck use visual displays to attract a mate. Studies of

Long-tailed Ducks (*Clangula hyemalis*) have identified at least a dozen distinct displays performed by courting males, including head-shaking, neck-stretching and wing-flapping. Duck courtship displays are usually confined to the water, but some species display in the air. Many people are familiar with the display flight of the American Woodcock (*Scolopax minor*) at dawn and dusk in early spring. It flies high up into the air in a vertical spiral, while making a twittering sound with its wing feathers. Back on the ground, a repetitive, nasal “peent” sound signals its presence as it prepares for its flight. Other methods of courtship include nest building (e.g. Marsh Wren, *Cistothorus palustris*) and providing food (e.g. Osprey, *Pandion haliaetus*). Because courtship is fundamental to the breeding biology of birds, it has been well studied, leading to many new theories and discoveries, particularly in the areas of evolution and sexual selection (selection based on characteristics such as song, colouration and displays meant especially to attract mates.)

Status of knowledge

Birds are perhaps the best studied group covered in this report largely because they are relatively easy to observe. They are economically important, and popular with scientists, naturalists and the public. In general, the basic biology and physiology of birds are well understood, and the distribution of birds in Canada is probably better understood than for any other group of wildlife in the country. Regular, long-term surveys, such as the North American Breeding Bird Survey (BBS), the Maritime Shorebird Survey and the National Harvest Survey of waterfowl, allow population size and trends to be estimated for a range of bird species. To complement surveys that monitor population sizes and trends, other regional and nationwide surveys, such as nest record schemes and the Monitoring Avian Productivity and Survivorship (MAPS) program, provide information on the life history and reproductive success of many different bird species.

Although huge progress has been made in studying bird distribution, populations and ecology, some groups of birds have proven difficult to sample adequately. In particular, birds breeding in northern Canada are not well surveyed by important schemes such as the BBS, due to the vast area and difficulty in accessing much of northern Canada. Other programs, such as the Christmas Bird Count (CBC) and the Canadian Migration Monitoring Network, which survey birds in the winter and during migration respectively, help to fill this gap. However, more work is needed to understand the distribution, population sizes and trends of northern birds. Scientists are currently developing new methods to monitor bird populations not well covered by the traditional surveys. In addition, species such as the crossbills (genus *Loxia*) and the redpolls (genus *Acanthis*), whose breeding density and patterns of movement are governed by cycles in their food sources, are difficult to survey and monitor. Ongoing work in the field of statistical analysis, efforts to standardize survey methods, and development of Internet tools allowing members of the public to enter data, means that scientists are increasingly able to make use of data collected through a variety of programs relying on volunteers.

Richness and diversity in Canada

A total of 664 bird species have been found in Canada. Bird species richness is highest in western and central Canada, peaking in British Columbia (502 species) and Ontario (483 species). Species richness is lower in the three northern territories than in the provinces, but the territories provide core breeding habitat for a number of bird species, particularly shorebirds. Compared to the other species groups covered in this report, the proportion of bird species ranked Accidental is high across the country, reflecting the mobile and migratory nature of many species (figure 24). So-called accidental occurrences can result from bad weather conditions that blow migrating birds off-course, or when juvenile birds stray many kilometers from their normal migration routes. The percentage of species ranked Accidental peaks in eastern Canada (35-45%), which receives accidental species from the Americas, Europe and Africa, as well as wandering seabirds.

Species spotlight - Atlantic Puffin

The Atlantic Puffin (*Fratercula arctica*) is a pigeon-sized seabird easily recognized by its striking black and white plumage and large, colourful bill. As its name suggests, it is found in the northern Atlantic Ocean where it breeds on the east coast of Canada, the northeast coast of the United States and the coasts of Greenland, Europe and Russia. Atlantic Puffins typically breed in dense colonies on grassy slopes or cliff-tops of small islands. Colonies consist of many pairs of puffins, each with its own nesting burrow, which they defend vigorously. Adult puffins dig the burrows with their large bills, strong feet and sharp claws. Burrows may be reused by the same pair for many years. The female lays one egg at the back of the tunnel, then both parents take turns incubating the egg and, eventually, feeding the chick. Once the young birds are independent, Atlantic Puffins leave the land and spend the rest of the year feeding at sea. Atlantic Puffins typically breed for the first time when they are five years old and can live up to about 25 years.

Atlantic Puffins feed on small marine fishes which they pursue under water. Using their short wings as paddles, they “fly” through the water, capturing fish from large schools of Capelin (*Mallotus villosus*), herring (family *Clupeidae*) or other small species. In flight, puffins flap their wings extremely quickly (300-

400 times per minute!) Wing size for this bird and other diving bird species is a compromise between flight, for which large wings are better, and swimming, for which small wings are better.

Like other seabirds, the Atlantic Puffin has a low rate of reproduction, although long-lived adults may reproduce many times during their lives. In the past, puffins were harvested for food and for their feathers, leading to population declines in North America and Europe, but this pressure has now largely been removed. Today, Atlantic Puffins and other seabirds are vulnerable to pollution (including oil spills and other environmental contamination), reduced food supply, drowning in fishing nets, and predation and competition from gulls. Atlantic Puffins are difficult to monitor, because their breeding grounds are remote and because they nest underground. Atlantic Puffins have a Canada General Status Rank (Canada rank) of Secure.

Species spotlight - Western Screech-Owl

The Western Screech-Owl (*Megascops kennicottii*) is a small, nocturnal owl with large eyes and ear tufts. It has a diverse diet of insects and small mammals and has even been observed catching and eating crayfish and bats! Like many other owls, the Western Screech-Owl has numerous adaptations to nocturnal hunting. Their excellent eyesight and hearing help them to detect their prey, while the leading edge of their flight feathers is serrated, allowing them to fly silently, so that prey are not aware of their approach. Also, their strong, sharp talons are adapted for grasping and carrying heavy food items. Owls swallow their prey whole, but they can’t digest the bones, fur or feathers. These are separated from the meat, and coughed back up as a pellet. Scientists study the distribution and contents of owl pellets to learn what habitats the owls are using and what they are eating.

Western Screech-Owls do not migrate. Instead they spend the whole year with their mate defending their territory. Western Screech-Owls nest in natural tree cavities, old woodpecker holes or nest-boxes. Males and females share nesting duties; females incubate the eggs and guard the nest, while males bring food for both the female and the young. Like many species of owl, young Western Screech-Owls leave the nest before they can fly so the parents must spend several more weeks feeding them before they are independent. Western Screech-Owls nest in deciduous and mixed-wood forests reaching their highest densities close to rivers or other water sources.

Within Canada, Western Screech-Owls are found primarily in British Columbia, although a few records exist in Alberta and Saskatchewan. The two subspecies of the Western Screech-Owl known to occur in Canada were both were assessed by COSEWIC in 2002. The *macfarlanei* subspecies (*Megascops* *kennicotti macfarlanei*) was assessed as Endangered, and the *kennicottii* subspecies (*Megascops kennicotti kennicottii*) was assessed as Special Concern. Western Screech-Owl has a Canada rank of Sensitive, which has changed from Secure in 2000, due to the 2002 COSEWIC reports.

Species spotlight - Red-headed Woodpecker

The Red-headed Woodpecker (*Melanerpes erythrocephalus*) is a medium-sized, colourful woodpecker that lives in southeastern Canada, south-central Canada and the eastern United States. This noisy and intriguing species has a varied diet of insects and plant matter including seeds, nuts, corn, berries and fruit. One of the Red-headed Woodpecker's favourite methods for catching insects is known as "fly-catching" (flying out from a perch to capture insects in mid-air), behaviour usually considered more typical of flycatchers, like the Eastern Kingbird (*Tyrannus tyrannus*), than woodpeckers! Red-headed Woodpeckers are one of the few species of woodpecker known to regularly store food, and the only woodpecker species known to cover stored food with wood or bark.

Red-headed Woodpeckers typically nest in open, deciduous forest, with trees widely spaced and plenty of dead trees (snags) for nesting and feeding. Red-headed Woodpeckers are known as primary cavity nesters because they excavate their own nest hole, usually in dead wood. Once they have finished with their cavity, it is often reused by other animals such as squirrels or American Kestrels (*Falco sparverius*). Red-headed Woodpeckers defend their nest vigorously against members of their own species and other possible competitors like Pileated Woodpeckers (*Dryocopus pileatus*), European Starlings (*Sturnus vulgaris*) and Red-bellied Woodpeckers (*Melanerpes carolinus*). In the fall, most Red-headed Woodpeckers migrate south to spend the winter in the United States. Their wintering areas are not fixed, but vary from year to year, depending mainly on the availability of their winter foods (primarily beechnuts and acorns).

Red-headed Woodpeckers have undergone large fluctuations in population size since European settlers first arrived in North America. The small-scale clearing of forests by early settlers created forest edges and clearings, which provided good breeding habitat for Red-headed Woodpeckers. However, as huge tracts of forest in eastern North America were logged, their winter food supply declined, as did the Red-headed Woodpecker. More recently, large-scale die-offs of Elm trees (genus *Ulmus*) and American Chestnut trees (*Castanea dentata*) in the middle of the last century left behind numerous large, decaying trees. This probably benefited Red-headed Woodpeckers by providing suitable nesting and feeding sites. Since 1966, Red-headed Woodpecker populations have been tracked across North America by the North American Breeding Bird Survey (BBS). Analysis of BBS trends suggests that Red-headed Woodpeckers have been undergoing significant declines across North America since the beginning of the survey, at a rate of about -2.7% per year. This suggests that the number of Red-headed Woodpeckers in North America may have declined by about 65% since 1966! The primary reason for population declines is thought to be loss of breeding habitat, due to removal of large dead trees.

The Red-headed Woodpecker was first assessed by COSEWIC in 1996 and was designated as Special Concern. This was changed to Threatened in 2007 due to a combination of new information about population size and the high rate of population decline.

Results of general status assessment

More detailed information is available about bird populations than for any other groups of species covered in this report. Anyone looking at the general status ranks for birds should keep in mind that these are by definition highly generalized. General status ranks should be considered together with the findings of the various bird population monitoring programs mentioned earlier and other relevant research. BBS data, in particular, show cases where bird species are undergoing population declines over various time periods, despite appearing to be plentiful or secure in most or all provinces or territories. Population trends based on BBS data for Canadian species can be viewed on the Canadian Bird Trends website.

For all groups covered in this report, national ranks are generally assigned based on the regional rank with the lowest level of risk. For example if the provincial and territorial ranks for a species are a mixture of Sensitive and Secure, the default Canada rank is usually Secure. However, for birds, this is not always the case. With the better knowledge we have on these species, the provincial and territorial ranks can be weighted according to the distribution of the birds when determining the Canada rank. Special considerations in regards to the breeding range of the species in Canada are also taken into account. Therefore, many of the Canada rank changes for birds are due primarily to the different procedures followed in 2000, 2005 and 2010, and are classified as procedural changes. These changes help to ensure that Canada ranks are comparable both within and among species groups.

The majority of Canada’s bird species are migratory, using different habitats at different latitudes throughout the year. This exposes them to an array of threats at different times during their life cycle. When Canada ranks were created for migratory birds, particular attention was paid to each species’ status on its breeding grounds. For example, within Canada, the Ruddy Turnstone (*Arenaria interpres*) breeds primarily on the tundra in northern Nunavut. There it is ranked Sensitive due to population declines. However, the species is a common migrant in suitable habitat in parts of southern Canada, and is ranked Secure in every province. Nevertheless, Ruddy Turnstone received a Canada rank of Sensitive due to concerns within its breeding range. This kind of exception was applied to approximately 16 bird species and is documented in the comments section of the general status database.

Just over half of the bird species found in Canada are ranked as Secure (52%, 344 species; figure 24 and table 34). However, nearly a third of bird species have Canada ranks of Accidental (30%, 203 species), the highest percentage of Accidental species of any group covered in this report. In addition, 7% of bird species have Canada ranks of Sensitive (49 species), 6% have Canada ranks of At Risk (37 species), 2% have Canada ranks of May Be At Risk (12 species) and less than 1% have ranks of Extinct (three species) or Extirpated (one species). According to our data, exotic species account for 2% of bird species (11 species) and less than 1% have Canada ranks of Undetermined (four species). No species are in the Not Assessed category.

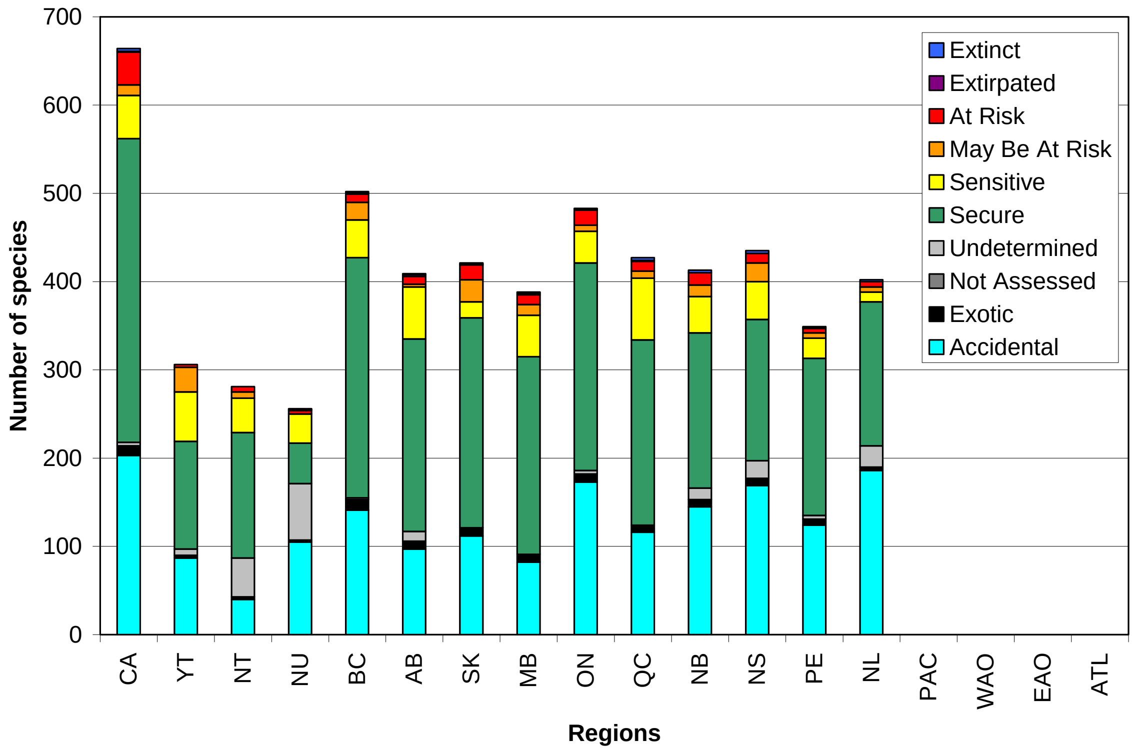

Figure 24. Results of the general status assessments for bird species in Canada in the *Wild Species* 2010 report.

Comparison with previous Wild Species reports

The total number of bird species ranked in Canada has changed from 639 in 2000 to 653 in 2005 to 664 in 2010 (table 34). Since 2000, a total of 25 new bird species have been added to the national list. Most of these species have Canada ranks of Accidental, and many have been recorded from only one province or territory. Some taxonomic changes also have resulted in the appearance of new species names in the 2010 Canada list. The Blue Grouse (*Dendragapus obscurus*) is now considered to be two species: Dusky Grouse (*D. obscurus*) and Sooty Grouse (*D. fuliginosus*). Also, the accidental species Bean Goose (*Anser fabalis*) has been split into two species. Occurrences of the now-split Bean Goose have been attributed to Tundra Bean-Goose (*Anser serrirostris*). Several species have had changes to the genus or species part of their scientific name, and there have been some changes to species names related to naming conventions and taxonomic decisions, but these do not affect the species' status.

A total of 41 species had a change in their Canada rank since the last assessment. Among these changes, 23 species had an increased level of risk, one species had a reduced level of risk, four species were changed from or to the ranks Undetermined or Accidental, 12 species were added and one species was deleted. The changes were mostly due to new or updated COSEWIC assessments, to biological changes in the distribution of the species, and to procedural changes (table 35). Over both time spans, the number of species ranked as At Risk and Accidental had the highest increases.

Table 34. Changes in the number of bird species over time in each rank category as determined by the National General Status Working Group.

	Canada rank	Years of the *Wild Species* reports			Average change between reports	Total change since first report
		2000	2005	2010		
0	Extinct / Extirpated	4 (1%)	4 (0%)	4 (0%)	Stable	Stable
1	At Risk	21 (3%)	27 (4%)	37 (6%)	+8 species	+16 species
2	May Be At Risk	11 (2%)	12 (2%)	12 (2%)	+1 species	+1 species
3	Sensitive	53 (8%)	41 (6%)	49 (7%)	-2 species	-4 species
4	Secure	345 (54%)	358 (55%)	344 (52%)	-1 species	-1 species
5	Undetermined	17 (3%)	5 (1%)	4 (1%)	-7 species	-13 species
6	Not Assessed	2 (0%)	0 (0%)	0 (0%)	-1 species	-2 species
7	Exotic	13 (2%)	11 (2%)	11 (2%)	-1 species	-2 species
8	Accidental	173 (27%)	195 (30%)	203 (30%)	+15 species	+30 species
	TOTAL	639 (100%)	653 (100%)	664 (100%)	+13 species	+25 species

Table 35. Reasons for changes in the status of bird species between the last assessment and the current report.

Scientific name	English name	2005 Canada rank	2010 Canada rank	Reason for change
Aethia pusilla	Least Auklet	-	8	(I) This species was added to the *Wild Species* database in 2010 due to new information about an old accidental record for the Northwest Territories (AOU, 1998).
Alle alle	Dovekie	4	3	(P) The change is due to a procedural change (different way of assessing the same information).
Anas fulvigula	Mottled Duck	-	8	(B) Added to the *Wild Species* database in 2010 due to a new accidental record in Ontario.
Anser anser	Graylag Goose	-	8	(B) New occurrence in Canada.
Ardea cinerea	Gray Heron	-	8	(B) New accidental record from Newfoundland and Labrador.
Buteo regalis	Ferruginous Hawk	2	1	(C) This species is now recognized by COSEWIC as Threatened.
Butorides striatus	Green-backed heron	8	-	(E) Error in previous rank, this species never occured in Canada.
Calcarius ornatus	Chestnut-collared Longspur	4	1	(C) This species is now recognized by COSEWIC as Threatened.

Calidris alpina	Dunlin	4	3	(B) Change due to change in species' population size, distribution or threats.
Calidris canutus	Red Knot	2	1	(C) The *rufa* subspecies of this species is now recognized by COSEWIC as Endangered, the *roselaari* subspecies is recognized as Threatened, and the *islandica* subspecies is recognized as Special Concern.
Caprimulgus vociferus	Whip-poor-will	4	1	(C) This species is now recognized by COSEWIC as Threatened.
Catharus bicknelli	Bicknell's Thrush	3	1	(C) This species is now recognized by COSEWIC as Threatened.
Chaetura pelagica	Chimney Swift	3	1	(C) This species is now recognized by COSEWIC as Threatened.
Charadrius alexandrinus	Snowy Plover	8	2	(P) The change is due to a procedural change (different way of assessing the same information). The species is known to breed in Saskatchewan. This was known in 2005.
Chordeiles minor	Common Nighthawk	4	1	(C) This species is now recognized by COSEWIC as Threatened.
Chroicocephalus ridibundus	Black-headed Gull	4	3	(P) The change is due to a procedural change (different way of assessing the same information).

Contopus cooperi	Olive-sided Flycatcher	4	1	(C) This species is now recognized by COSEWIC as Threatened.
Dendragapus fuliginosus	Sooty Grouse	-	3	(T) This species was added to the Canada list in 2010 due to a taxonomic split. It used to be considered conspecific with Dusky Grouse, under the name of Blue Grouse (AOU, 2006).
Egretta gularis	Western Reef-Heron	-	8	(B) New accidental records in Nova Scotia and Newfoundland and Labrador.
Falco peregrinus	Peregrine Falcon	4	3	(P) The change is due to a procedural change (different way of assessing the same information).
Fulmarus glacialis	Northern Fulmar	4	3	(B) Change due to change in species' population size, distribution or threats.
Haematopus palliatus	American Oystercatcher	8	5	(B) Change due to change in species' population size, distribution or threats (the species have been found to breed in Nova Scotia).
Hydrocoloeus minutus	Little Gull	3	2	(P) Change due to a procedural change (different way of assessing the same information).
Larus thayeri	Thayer's Gull	4	3	(B) Change due to change in species' population size, distribution or threats.

Leucophaeus atricilla	Laughing Gull	4	3	(P) Change due to a procedural change (different way of assessing the same information).
Melanerpes erythrocephalus	Red-headed Woodpecker	2	1	(C) This species is now recognized by COSEWIC as Threatened.
Melanerpes lewis	Lewis's Woodpecker	3	2	(B) Change due to change in species' population size, distribution or threats.
Myiarchus tyrannulus	Brown-crested Flycatcher	-	8	(B) Added to the Canada list in 2010 due to a new accidental record for British Columbia.
Oceanodroma homochroa	Ashy Storm-petrel	-	8	(B) Biological change.
Phalaenoptilus nuttallii	Common Poorwill	4	3	(P) Change due to a procedural change (different way of assessing the same information).
Phoebastria immutabilis	Laysan Albatross	5	3	(I) Change due to improved knowledge of the species.
Phoebastria nigripes	Black-footed Albatross	4	3	(I) Change due to improved knowledge of the species.
Progne subis	Purple Martin	4	3	(B) Change due to change in species' population size, distribution or threats.
Pterodroma cookie	Cook's Petrel	-	8	(B) Added to the Canada list in 2010 due to a new accidental record for British Columbia.
Puffinus puffinus	Manx Shearwater	4	3	(P) Change due to a procedural change (different way of assessing the same information).

Spinus spinus	Eurasian Siskin	-	8	(B) This species was added to the *Wild Species* database for 2010 due to an accidental record from Newfoundland and Labrador.
Stercorarius skua	Great Skua	5	4	(P) Change due to a procedural change (different way of assessing the same information).
Sterna forsteri	Forster's Tern	3	4	(B) Change due to change in species' population size, distribution or threats.
Vermivora luciae	Lucy's Warbler	-	8	(B) New accidental record in Alberta.
Vireo flavoviridis	Yellow-green Vireo	-	8	(B) New accidental record for Quebec.
Wilsonia canadensis	Canada Warbler	4	1	(C) This species is now recognized by COSEWIC as Threatened.

Threats to Canadian birds

The major threats to Canadian birds are well known and include habitat loss and fragmentation; pollution and contamination; predation and brood parasitism; disease; over-exploitation; competition from invasive or exotic species; other forms of human-caused mortality (e.g. building and tower strikes and, road traffic); and natural and anthropogenic climate and weather variation. Threats in migratory stopover and wintering sites complicate the situation. Therefore, many bird population research and monitoring programs involve international co-operation to study the same species in different locations and at different points in the life cycle.

Conclusion

Canada provides important breeding habitat for many species of North American birds, and many Canadians appreciate the diversity and abundance of birds that spend all, or part of the year here. For these reasons, and many others, it is important to update general status ranks for birds regularly. This update allows Canada ranks to be adjusted to the actual situation, ensures that ranks are comparable within and among species groups, and allows the national list to be updated with species new to Canada. Although birds are generally better studied than other groups covered in this report, it is still important to improve our knowledge of bird populations, particularly for species breeding in northern Canada and other remote locations, and for species not adequately covered by current surveys.

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Mammals

Mammalia - Class of vertebrates that contains any warm-blooded animals, members of which are characterized by the possession of mammary glands and a four-chambered heart, including human beings, carnivores, ungulates, rodents, whales, etc.

Quick facts

- There are more than 5000 known species of mammals, divided into 26 orders. The rodents are the largest order of mammals in the world, both in terms of number of species, and number of individuals.

- A total of 218 species of mammal have been found in Canada, including 169 species ranked in the provinces and territories and 49 ranked in the ocean regions.

- When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, the majority (72%) of mammals in Canada have Canada General Status Ranks (Canada ranks) of Secure, while 16% have Canada ranks of Sensitive, 6% have Canada ranks of At Risk and 6% have Canada ranks of May Be At Risk.

- One species of mammals is extirpated from Canada and one species that used to be present in Canada is now Extinct.

- Most changes in the general status ranks of mammals in *Wild Species* 2010 were due to taxonomic changes or COSEWIC detailed assessments.

- The world's largest mammal is the Blue Whale (*Balaenoptera musculus*), which can grow up to 25 m long and weigh up to 100 tonnes.

Polar Bear, *Ursus maritimus* © Gordon Court

Background

From the Atlantic Walrus (*Odobenus rosmarus*) of the frozen Arctic, to the American Bison (*Bison bison*) of the prairies, to the Red Squirrel (*Tamiasciurus hudsonicus*) in your backyard or local park, mammals are a familiar and diverse group found throughout Canada. Mammals are able to endure Canada's varied and sometimes harsh climate because they are warm-blooded (endothermic). This means that mammals are able to keep their core body temperature stable, despite outside temperature fluctuations. Mammals are believed to have evolved from a group of reptiles, called the synapsids, more than 200 million years ago, slightly before the dinosaurs appeared on earth. Since the disappearance of the dinosaurs, about 65 million years ago, mammals have spread and diversified to reach their present, global distribution.

One of the defining characteristics of mammals is the possession of hair, from the short, velvety hair of the Townsend's Mole (*Scapanus townsendii*), to the thick, shaggy coat of the Muskox (*Ovibos moschatus*). The most important function of hair is to provide insulation from the cold. For example, the hair of the Arctic Fox (*Vulpes lagopus*) provides such efficient insulation that they can remain active even at temperatures below -50°C! Some mammals loose their hair as adults, so they use other methods of insulation. For example, Cetaceans (whales, dolphins and porpoises) which loose their hair soon after birth, are insulated by a thick layer of blubber. Other important uses of hair include camouflage (e.g. the white, winter coat of the Snowshoe Hare, *Lepus americanus*) and communication (e.g. the White-tailed Deer, *Odocoileus virginianus*, uses its white tail to flash a danger signal as it runs from a predator). There are two main types of hair, underfur and guardfur, each with its own function. The thick, soft underfur traps a layer of warm air to insulate the body, while the guardfur acts to protect the underfur. The long, soft underfur of the Muskox is one of the most luxurious and expensive natural fibres in the world.

All female mammals possess mammary glands, which produce milk to feed their young. Milk is rich in proteins and fat, and provides the young with the nutrients and energy they need to develop and grow. While they depend on their mother for milk, the young develop social behaviours and learn about their environment, including which foods are good to eat and how to find them. Some mammals, such as the Caribou (*Rangifer tarandus*), give birth to precocial young, which are well developed and can run almost immediately after birth. Young Caribou stagger to their feet less than an hour after birth, and can run fast enough to keep up with the herd within the first day or two of life. In contrast, altricial young are born helpless, often blind, and with very limited mobility. For example, Eastern Grey Squirrels (*Sciurus carolinensis*) are born naked and toothless, and their eyes and ears are scarcely visible. It takes over a month before their eyes begin to open, and almost two months before they venture outside the nest.

Some of Canada’s most distinctive mammals are those that live in the Arctic tundra, including the Polar Bear (*Ursus maritimus*), Arctic Fox, Caribou, Muskox, and several different types of lemming. While some of these mammals, such as the Caribou, migrate south during the winter, many are resident on the tundra year round. Arctic mammals show many adaptations to the extreme cold, including thick fur coats and high metabolic rates. Several Arctic mammals, such as the Muskox and Polar Bear, have evolved a large size and compact shape to reduce heat loss. Small mammals, such as the Northern Bog Lemming (*Synaptomys borealis*) spend the winter under the snow. Deep snow acts as an insulating layer, protecting the lemmings from extreme surface temperatures. Many Arctic mammals keep their extremities at temperatures close to freezing while their core body temperature does not fluctuate. For example, the temperature of a Caribou’s legs can be as much as 10°C cooler than its core body temperature. This is accomplished by a special arrangement of blood vessels that allow the warmth of the blood being pumped to the extremities to heat the blood returning to the core (this system is called counter-current heat exchange). Only one Arctic mammal, the Arctic Ground Squirrel (*Spermophilus parryii*), undergoes true hibernation, during which its body temperature drops far below normal.

Harbour Porpoise, *Phocoena phocoena* © Ari S. Friedlaender

Status of knowledge

In general, mammals in Canada have been well-studied, and the basic biology and physiology, distribution and ecology of many mammal species are well understood. In recent years, technological advances including satellite telemetry and new genetic tools have been used to further improve knowledge of Canadian mammals. However, there remain challenges that make studying mammals in the wild difficult, including nocturnal or secretive behaviour, remote distribution, difficulty in handling wild mammals and the vast distances covered by some large mammals. In addition, many marine mammals can be difficult to study due to the long time spent under water, and the short time spent at the surface.

A major focus of mammalogy in Canada has been studies of large mammals, such as Caribou, Wapiti (also known as Elk, *Cervus elaphus*) and Polar Bears. Large mammals are important to study because of their economic value, potential for conflict with humans and their importance in the ecosystems in which they live. For example, recent research in Banff National Park has shown that by controlling the Wapiti population, Grey Wolves (*Canis lupus*) have an indirect impact on the local vegetation structure and bird communities. In areas of high Grey Wolf density, there are fewer Wapiti, more regenerating vegetation, more warblers and fewer sparrows. Studies like this demonstrate the importance of large mammals in shaping their local ecosystems.

Tracking mammals at sea is a difficult task, and can limit research on deep-sea marine mammals, but new technology, including satellite tracking, satellite remote sensing and acoustic remote sensing, is helping to improve knowledge in this area. For example, Blue Whale (*Balaenoptera musculus*) migration and habitat use has been followed using acoustic and satellite remote sensing, allowing continuous, large-scale, spatial and temporal tracking of Blue Whale movements for the first time.

In general, mammals that are not considered economically or culturally important (such as shrews, family *Soricidae*), have not been studied as well as large, charismatic or economically important mammals, like the Polar Bear or Caribou. For example, bats (order *Chiroptera*) are generally less well-studied and less well understood than many other mammal groups, and the distribution, ecology and life history of some bats in Canada is still poorly known. However, new studies are starting to close this gap. For example, recent surveys in Nova Scotia discovered Canada's first known breeding colony of Eastern Pipistrelles (*Pipistrellus subflavus*). Other recent bat studies have focussed on habitat use, echolocation, diet and thermal ecology of bats.

Richness and diversity in Canada

There are nine orders of mammals in Canada, of which the rodents (Order Rodentia), is by far the most species rich. Of Canada's 218 mammal species, 169 are ranked only in the provinces and territories and 49 are ranked only in the ocean regions. British Columbia (119 species, figure 25) has the highest species richness of mammals in Canada, due primarily to high numbers of insectivores (order *Insectivora*) and bats (order *Chiroptera*) found in the province.

The majority of Canada's 49 species of marine mammals are found in the Atlantic Ocean Region (32 species) or the Pacific Ocean Region (30 species, figure 25).

Species spotlight - Northern Long-eared Myotis

The Northern Long-eared Myotis (*Myotis septentrionalis*) is a medium-sized bat found in all the provinces and territories except Nunavut. Like all Canada's bats, the Northern Long-eared Myotis is nocturnal; during the day it roosts under the peeling bark of decaying trees and at night it hunts for insects. The Northern Long-eared Myotis uses two main hunting techniques; catching insects that are resting on trees and bushes (gleaning) and catching insects in flight (hawking). In both cases, the Northern Long-eared Myotis uses echolocation to detect its prey. These bats are active only during the warmer months of the year (approximately April to September). During the rest of the year, they hibernate in caves or abandoned mines where the humidity is high and the temperature hovers just above freezing.

The nocturnal and secretive behaviour of the Northern Long-eared Myotis make this species difficult to study, but new technology is increasing the ability of scientists to investigate bat habitat use. For example, researchers can set up microphones in different habitats to record the sounds made by feeding bats. Since different species of bats make different sounds, computer programs can analyse the recordings and find out which species are feeding in which habitat type. In addition, by capturing bats and attaching tiny radio-transmitters, researchers can find out exactly which trees bats prefer to roost in. Results from these studies show that mature forest habitat, with large decaying coniferous and deciduous trees is important for these bats. This kind of information helps foresters and wildlife mangers make informed decisions about which types of habitat should be conserved to support healthy bat populations. Leaving individual mature deciduous and coniferous trees as well as patches of intact mature forest in harvested landscapes may help support Northern Long-eared Myotis populations. In turn, bats can help to control outbreaks of forest pests, such as Spruce Budworm (*Choristoneura fumiferana*).

The Northern Long-eared Myotis is more common in eastern and central Canada (ranked Secure or Sensitive) than in western and northern Canada (ranked May Be At Risk or Undetermined). This is due its preference for mature mixed wood forest, which is more widely available in eastern Canada, as well as the availability of suitable hibernation sites and climate. Due to its large range in Canada, Northern Long-eared Myotis has a Canada General Status Rank (Canada rank) of Secure.

Species spotlight - Northern Bottlenose Whale

The Northern Bottlenose Whale (*Hyperoodon ampullatus*) is named for its dolphin-like beak and prominent “egg-head” forehead, which is particularly large in adult males. They are found in the northern Atlantic Ocean, where they favour deep, cool water. Northern Bottlenose Whales are very sociable animals, and live in small groups, or pods. Males are larger than females and can reach up to 10 m in length, and weigh up to 7.5 tonnes! In males, the lower jaw of the beak holds two small teeth, but the female has no teeth at all. Northern Bottlenose Whales dive up to 1000 m in depth for as long as 70 minutes, searching for their favourite food of squid (genus *Gonatus*).

Two distinct populations of Northern Bottlenose Whales are found in Canada; one off the northern Labrador coast (Davis Strait population) and another off the southeast coast of Nova Scotia (Scotian Shelf population), within the Atlantic Oceanic Region. The Scotian Shelf population lives within an underwater canyon called The Gully. This population of about 130 animals has a unique migratory strategy and life history compared to other bottlenose whale populations.

Northern Bottlenose Whales were hunted for centuries for their spermaceti oil, which was used to make high quality lubricating oil and candles. Bottlenose whales were easy prey for whale hunters because they are attracted to boats by their intense curiosity. Pod-members are extremely protective of injured or distressed companions, so whalers were often able to harvest the majority of the pod, before the remaining members dived for safety. By the mid 1970’s global populations of Northern Bottlenose Whales were reduced to vulnerable levels. In 1973 commercial hunting ceased and in 1977 the species was classified as a protected species by the International Whaling Committee, but global populations of Northern Bottlenose Whales have not yet fully recovered. In Canada, the Davis Strait population is currently assessed as Not At Risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), but the Scotian Shelf population was assessed by COSEWIC as Endangered in 2002, and is now protected under Canada’s *Species at Risk Act*.

Fortunately for researchers, the Northern Bottlenose Whale’s sociable nature has made the study of its biology and behaviours relatively easy, since observers are able to approach the whales without disturbing them. The Gully, home of the Scotian Shelf population of Northern Bottlenose Whales, is a Marine Protected Area, but is surrounded by oil and gas discoveries and is close to trans-Atlantic shipping routes. Recent research in this area has attempted to determine the effects of human activities on the whales, including commercial shipping, fishing activity, and the offshore oil and gas industry. The Northern

Bottlenose Whale has a Canada general status rank of Sensitive; this has not changed since *Wild Species* 2000.

Species spotlight - Common Grey Fox

Common Grey Foxes (*Urocyon cinereoargenteus*) are the only member of the dog family (family *Canidae*) in Canada with the ability to climb trees! This small fox has short legs and long, strong back claws that allow it to scramble up tree trunks to escape from predators or look for food, such as fruit, birds and rodents. On the ground, Common Grey Foxes also eat rabbits and other small mammals. Slightly smaller and greyer in colour that the Red Fox (*Vulpes vulpes*), Common Grey Foxes are native to Ontario and have also been recorded in New Brunswick, Quebec, Manitoba and Alberta.

Common Grey Foxes have an intriguing history in Canada. Archaeological records from the villages of Aboriginal Peoples indicate that in the past, Common Grey Foxes were almost as abundant as Red Foxes in southern Ontario. However, the records of European settlers make no mention of this unusual species. In fact it wasn’t until early in the 1890s that Common Grey Foxes were reported first in Quebec, and then in Ontario. No one is certain what caused Common Grey Foxes to disappear from Ontario for more than 300 years, or why they have become re-established over the past 100 years. However, it has been suggested that warmer temperatures in recent years have allowed northern populations, like those in southern Ontario, to survive and increase. Today, the only place in Canada where Common Grey Foxes are known to breed is Pelee Island in southern Ontario. Records of Common Grey Foxes in other parts of Ontario and in southern Manitoba are probably single individuals that have travelled across the border from the United States, where Common Grey Foxes remain widespread.

Due to its small range and small population size in Canada, and because its forested habitat is under threat from human development, Common Grey Fox has a Canada rank of At Risk. This rank has changed from Not Assessed in the report *Wild Species* 2000, due to an updated COSEWIC status assessment of Threatened.

Results of general status assessment

The majority of mammals have Canada ranks of Secure (62%, 135 species, figure 25 and table 36). However, 13% have Canada ranks of Sensitive (29 species), 6% have Canada ranks of At Risk (12 species), 5% have Canada ranks of May Be At Risk (11 species), and a total of 1% have Canada ranks of

Extirpated (one species, Black-footed Ferret, *Mustela nigripes*) and Extinct (one species, Sea Mink, *Neovison macrodon*). In addition, 5% of mammal species have Canada ranks of Exotic (11 species), 5% have Canada ranks of Undetermined (11 species), and 3% have Canada ranks of Accidental (seven species).

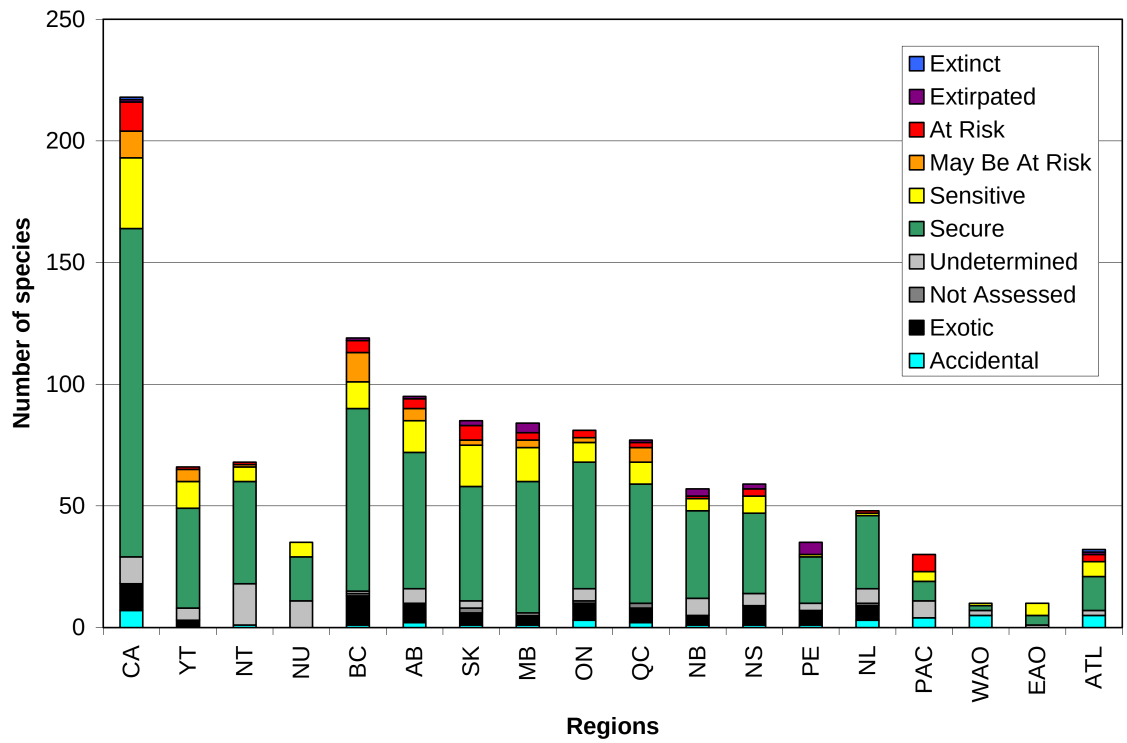

Figure 25. Results of the general status assessments for mammal species in Canada in the *Wild Species* 2010 report.

Comparison with previous Wild Species reports

Since the last assessment in 2005, the total number of mammal species remained stable (table 36). However, a total of 11 species had a change in their Canada rank. Among these changes, two species had an increased level of risk, two species had a reduced level of risk, three species were changed from the rank Undetermined, two species were added and two species were deleted. Most changes in the general status ranks of mammals in the *Wild Species* 2010 report are due to taxonomic changes, to improved knowledge of the species, and to new COSEWIC detailed assessments (table 37).

Table 36. Changes in the number of mammal species over time in each rank category as determined by the National General Status Working Group.

	Canada rank	Years of the *Wild Species* reports			Average change between reports	Total change since first report
		2000	2005	2010		
0	Extinct / Extirpated	2 (1%)	2 (1%)	2 (1%)	Stable	Stable
1	At Risk	8 (4%)	13 (6%)	12 (6%)	+2 species	+4 species
2	May Be At Risk	9 (4%)	10 (5%)	11 (5%)	+1 species	+2 species
3	Sensitive	29 (13%)	25 (11%)	29 (13%)	Stable	Stable
4	Secure	139 (65%)	139 (64%)	135 (62%)	-2 species	-4 species
5	Undetermined	10 (5%)	11 (5%)	11 (5%)	+1 species	+1 species
6	Not Assessed	3 (1%)	0 (0%)	0 (0%)	-2 species	-3 species
7	Exotic	11 (5%)	11 (5%)	11 (5%)	Stable	Stable
8	Accidental	4 (2%)	7 (3%)	7 (3%)	+2 species	+3 species
	TOTAL	215 (100%)	218 (100%)	218 (100%)	+2 species	+3 species

Table 37. Reasons for changes in the status of mammal species between the last assessment and the current report.

Scientific name	English name	2005 Canada rank	2010 Canada rank	Reason for change
Canis lycaon	Eastern Wolf or Eastern Timber Wolf	3	-	(T) This species is once again considered as a sub-species of *Canis lupus*.
Corynorhinus townsendii	Townsend's Big-eared Bat	2	3	(I) Improved knowledge of the species. This species is more common then previously thought.
Dicrostonyx kilangmiutak	Victoria Collared Lemming	4	-	(T) This species is no longer considered a valid species. It is now considered a sub-species of *Dicrostonyx groenlandicus*.
Dicrostonyx nunatakensis	Ogilvie Mountains Collared Lemming	5	2	(I) Improved knowledge of the species. It is very range restricted.
Enhydra lutris	Sea Otter	1	3	(C) Since the *Wild Species* 2005 report was published, COSEWIC re-assessed the species as Special Concern (previous assessment was Threatened).
Erignathus barbatus	Bearded Seal	4	5	(C) Since the *Wild Species* 2005 report was published, COSEWIC assessed the species as Data Deficient.
Myotis sodalis	Indiana Myotis	-	5	(I) Improved knowledge of the species. This species was only recently detected in Canada.
Ochotona collaris	Collared Pika	4	3	(B) Change in threats to the species. Climate warming is causing some local extirpations.

Orcinus orca	Killer Whale	5	3	(C) Ranked in Northwest Atlantic / Eastern Arctic populations as "Special concerns" by COSEWIC in November 2007.
Sorex rohweri	Olympic Shrew	-	2	(T) Taxonomically, this is a new species that was previously undetected by scientists until 2007.
Spilogale gracilis	Western Spotted Skunk	4	3	(B) Change in the biological status of the species.

Threats to Canadian mammals

Mammals are a large and varied group, and the threats facing them are similarly varied. Habitat loss, fragmentation and degradation are important threats for many mammal species, especially large mammals, habitat specialists and mammals whose range overlaps areas of dense human habitation. Other threats to Canadian mammals include overexploitation, disease, exotic species, hybridization and climate change.

Lack of information on mammals such as bats and shrews make it also difficult to detect or reverse population declines. For example, the white-nose syndrome in bats represents an important concern. This syndrome is characterized by the presence of white fungal growth on muzzles, ears, or wing membranes of affected bats. It affects bats that hibernate in caves, including the common Little Brown Bat (*Myotis lucifugus*). Since the winter of 2006-2007, massive mortalities of bats were observed in the north-eastern states of the United States. The disease has spread rapidly; and in early 2010, it was first confirmed in Ontario and Quebec. No one knows where white-nose syndrome came from, but one theory is that it was inadvertently transported by people from Europe. Emerging diseases such as white-nose syndrome are an example of how the conservation status could potentially change even for very common species.

Marine mammals typically face a different set of threats to freshwater and terrestrial mammals. In particular, human activities at sea can often be harmful to marine mammals. Two of the greatest threats are entanglements with fishing gear and collisions with boats. In addition, from petroleum activity, such as seismic exploration, and commercial ship traffic may cause physical damage to marine mammal hearing or interfere with their feeding, migration or communication. Commercial ship traffic is responsible for much of the noise pollution found in the world's oceans today. Considerable work remains to be completed to explore these impacts more fully.

Exposure of marine mammals to pollutants has been much publicised. For example, the resident Killer Whales (*Orcinus orca*) of the Pacific coast are among the most contaminated marine mammals in the world. Marine mammals are vulnerable to pollutants for several reasons including their position at, or close to, the top of the food chain, and their long life cycles. Marine mammals generally do not metabolise pollutants well. Instead they are stored in the blubber, from where they can be passed to the young during suckling, or to predators, including humans. Marine mammals with high levels of contamination can face reduced survival and suppression of the immune system leading to increased rates of disease. However, it if difficult to make direct links between high levels of contamination and population declines.

Conclusion

Compared to terrestrial and freshwater mammals, the proportion of marine mammals ranked Secure is low, and the proportion of marine mammals with Canada ranks of At Risk, Sensitive or Undetermined is high. This reflects both the increased risks faced by marine mammals, as well how much more we need to learn about marine ecosystems and the species that live there.

This updated general status assessment of mammals allowed the general status national mammal lists to be updated with the latest scientific knowledge. The Canada ranks of most of the mammal species were not changed, resulting that the overall proportion of mammal species in each of the general status categories has not changed substantially over the last assessments.

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Section 4 – Conclusion

Summary of the results

Previous *Wild Species* reports presented the general status assessments for respectively 1670 species in the 2000 report and for 7732 species in the 2005 report. In the *Wild Species* 2010 report, the general status assessments of 11 950 species are presented. This report represents a huge achievement, by publishing the results for 20 taxonomic groups, including lichens, mosses, vascular plants, freshwater mussels, spiders, odonates, predaceous diving beetles, ground beetles, lady beetles, bumblebees, black flies, horse flies, mosquitoes, some selected macromoths, butterflies, crayfishes, amphibians, reptiles, birds and mammals. The largest group assessed was the vascular plants, with 5111 species, demonstrating the commitment of botanists across the country to assessing and conserving Canada's plants. The most species-rich regions are Ontario (6995 species, figure 26), British Columbia (6841 species) and Quebec (6150 species), due to the variation in climate and geology that provide diverse habitats in which different species can survive. However, the region with the highest diversity (species richness/area) is Prince Edward Island; the region where you can see the highest number of species in the smallest area!

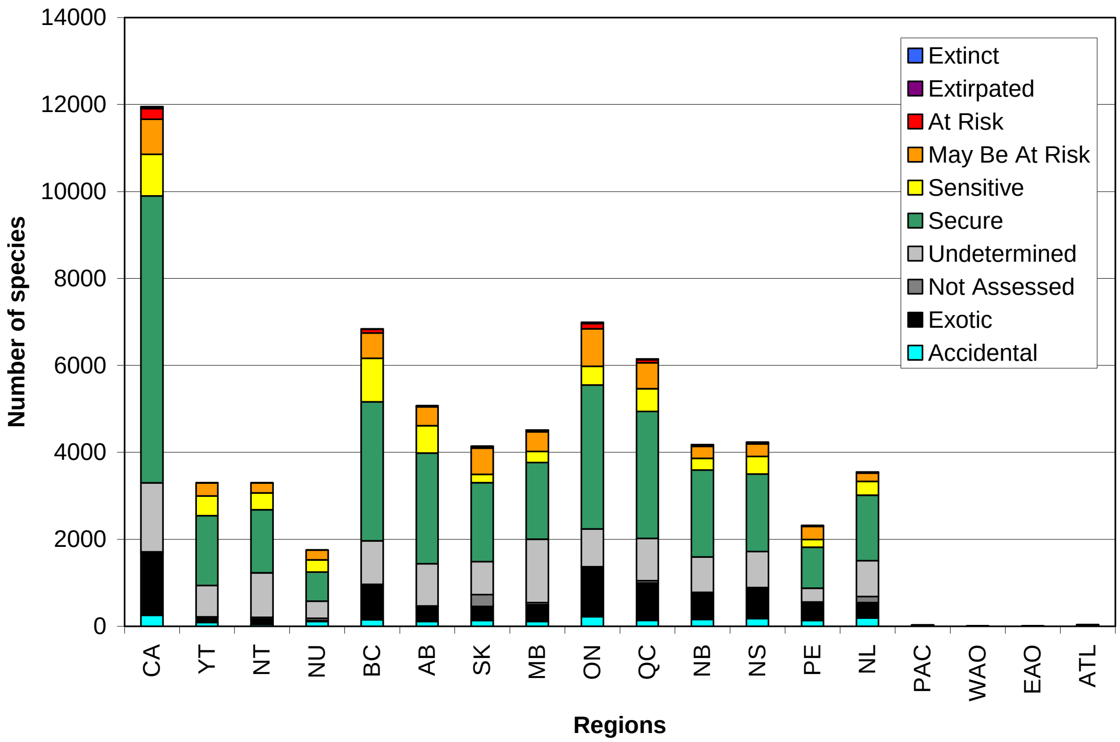

Figure 26. Results of the general status assessments for all species in the *Wild Species* 2010 report in Canada.

Proportion of species ranked as Secure

The majority of the 11 950 species assessed in this report received Canada ranks of Secure (6600 species, 55%). However, part of the variation in the proportion of species with low or high levels of risk is associated with variation in the proportion of species with Canada ranks of Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental (e.g. bumblebees have a large proportion of species ranked Undetermined, and a correspondingly small proportion of species ranked Secure). Therefore, to get a clearer picture of which species groups are most secure, or most at risk, we can focus just on species with Canada ranks of At Risk, May Be At Risk, Sensitive and Secure (table 38). The proportion of species ranked as Secure within these categories ranged from 33% to 98%. Reptiles (33%) and freshwater mussels (39%) are the taxonomic groups that have the lowest proportion of species ranked as Secure. At the opposite, ground beetles (88%), bumblebees (94%), mosquitoes (95%) and predaceous diving beetles (98%) were the taxonomic groups that had the highest proportion of species ranked as Secure. However, the high percentages of species ranked as Secure in these taxonomic groups might still reflect our lack of knowledge on these species, since they were also among the taxonomic groups with the highest proportion of species ranked as Undetermined or Not Assessed.

When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental, 77% of the species assessed in the *Wild Species* 2010 report had Canada General Status Ranks (Canada ranks) of Secure.

Table 38. Number of assessed species (*n* = 11 950) in the *Wild Species* 2010 report according to the different taxonomic groups.

Taxonomic group	Number of species	Proportion of Secure*
Lichens	861	72%
Mosses	1006	76%
Vascular plants	5111	71%
Molluscs		
- Freshwater mussels	54	39%
Spiders	1379	86%
Insects		
- Odonates	211	78%
- Predaceous diving beetles	275	98%
- Ground beetles	934	88%
- Lady beetles	166	84%
- Bumblebees	41	94%
- Black flies	162	91%
- Horse flies	144	85%
- Mosquitoes	80	95%
- Selected macromoths	236	84%
- Butterflies	302	82%
Crustaceans		
- Crayfishes	11	78%
Amphibians	47	67%
Reptiles	48	33%
Birds	664	78%
Mammals	218	72%
TOTAL	11 950	77%

* When excluding species ranked as Extinct, Extirpated, Undetermined, Not Assessed, Exotic or Accidental.

Species ranked as May Be At Risk

One of the aims of the *Wild Species* series is to help COSEWIC prioritize species for detailed status assessments. The species that are ranked as May Be At Risk by the National General Status Working group are species that could be candidates for more detailed assessments by COSEWIC. In this report, a total of 806 species were ranked as May Be At Risk (table 39). The taxonomic groups that had the most species ranked as May Be At Risk were the vascular plants (444 species), followed by lichens (100 species), mosses (71 species) and spiders (62 species). The complete list (among assessed taxonomic groups) of species ranked as May Be At Risk can be found on the *Wild Species* website in the database or in the search tool.

Table 39. Number of species ranked by the National General Status Working Group as May Be At Risk at the Canada level that could be potential candidates for a more detailed assessment by COSEWIC.

Taxonomic group	Number of species ranked as May Be At Risk	Proportion of all species ranked as May Be At Risk
Lichens	100	12%
Mosses	71	9%
Vascular plants	444	55%
Molluscs		
- Freshwater mussels	6	1%
Spiders	62	8%
Insects		
- Odonates	22	3%
- Predaceous diving beetles	2	1%
- Ground beetles	36	4%
- Lady beetles	0	0%
- Bumblebees	1	1%
- Black flies	0	0%
- Horse flies	11	1%
- Mosquitoes	0	0%
- Selected macromoths	9	1%
- Butterflies	19	2%
Crustaceans		
- Crayfishes	0	0%
Amphibians	0	0%
Reptiles	0	0%
Birds	12	1%
Mammals	11	1%
TOTAL	806	100%

Exotic species

Exotic species have been introduced to Canada, both deliberately and accidentally, from around the world. In addition, species with regional ranks of Exotic are often native species that have been moved from regions of the country in which they traditionally occur, to regions in which they are not naturally found. Whether from abroad, or from a different part of Canada, exotic species can cause problems for native species in a variety of ways, including competition for space and resources, predation, hybridization and introduction of new diseases. On the 11 950 species assessed, a total of 1426 species were ranked as Exotic. Most of the species that were given a Canada rank of Exotic in this report are vascular plants (1252 species), representing 89% of all Exotic species. Vascular plants have the highest proportion of Exotic species of any group covered in this report (table 40). Other taxonomic groups that had many Exotic species were the spiders (70 species) and the ground beetles (54 species). The complete list (among assessed taxonomic groups) of Exotic species can be found on the *Wild Species* website in the database or in the search tool.

Table 40. Number of species ranked by the National General Status Working Group as Exotic at the Canada level.

Taxonomic group	Number of species ranked as Exotic	Proportion of all species ranked as Exotic
Lichens	1	0%
Mosses	4	0%
Vascular plants	1252	89%
Molluscs		
- Freshwater mussels	0	0%
Spiders	70	5%
Insects		
- Odonates	0	0%
- Predaceous diving beetles	0	0%
- Ground beetles	54	4%
- Lady beetles	7	0%
- Bumblebees	0	0%
- Black flies	0	0%
- Horse flies	0	0%
- Mosquitoes	3	0%
- Selected macromoths	7	0%
- Butterflies	2	0%
Crustaceans		
- Crayfishes	2	0%
Amphibians	0	0%
Reptiles	2	0%
Birds	11	1%
Mammals	11	1%
TOTAL	1426	100%

Lack of knowledge

For most species groups and regions, the proportion of species ranked Undetermined or Not Assessed is variable. For some taxonomic groups such as vertebrates, the information on the status of the species is relatively well known. However, for other taxonomic groups, the amount of information is not as abundant. One purpose of this report is to encourage more information to be collected on species currently ranked as Undetermined or Not Assessed. In this report, a total of 1618 species had these ranks because of a lack of knowledge (table 41). The taxonomic group that had the highest number of species ranked as Undetermined or Not Assessed was the spiders (477 species), representing 29% of all the species with these ranks. Other taxonomic groups, such as ground beetles (260 species), mosses (235 species), and lichens (218 species) had also a large number of species ranked as Undetermined or Not Assessed. As well, approximately 60 000 Canadian species, primarily invertebrates, remain too poorly known for inculsion in this report. We hope that more information will become available for those groups as well.

Without information on the status of these species, it is difficult to judge how the human uses affect the ecosystems and species. As the *Wild Species* program assesses species groups which are not well-known or not well-studied in Canada, the proportion of species that receive ranks of Undetermined and Not Assessed is likely to rise.

Table 41. Number of species ranked by the National General Status Working Group as Undetermined or Not Assessed at the Canada level.

Taxonomic group	Number of species ranked as Undetermined or Not Assessed	Proportion of all species ranked as Undetermined or Not Assessed
Lichens	218	13%
Mosses	235	15%
Vascular plants	135	8%
Molluscs		
- Freshwater mussels	2	0%
Spiders	477	29%
Insects		
- Odonates	11	1%
- Predaceous diving beetles	64	4%
- Ground beetles	260	16%
- Lady beetles	67	4%
- Bumblebees	25	2%
- Black flies	34	2%
- Horse flies	23	1%
- Mosquitoes	11	1%
- Selected macromoths	29	2%
- Butterflies	11	1%
Crustaceans		
- Crayfishes	0	0%
Amphibians	0	0%
Reptiles	1	0%
Birds	4	0%
Mammals	11	1%
TOTAL	1618	100%

Changes in species status

One of the important achievements of this report is to update the status assessments of taxonomic groups that were included in previous *Wild Species* reports. Among the taxonomic groups that were reassessed in this report, a total of 626 species had a change in their Canada rank.

In total, 15% of the changes involved species moving into a rank with an increased level of risk (95 changes, table 42), 27% involved species moving into a rank with a reduced level of risk (166 changes), and 16% involved species moving into or out of the Undetermined, Not Assessed, Exotic or Accidental ranks (102 changes). Updates have also resulted in the addition of 162 new species to the national list (26% of the changes). Just as importantly, 101 species have been removed from the national list (16% of changes). Updating the national species lists in this way keeps the General Status program and the *Wild Species* series abreast of the latest scientific knowledge.

Most of these changes were due to improved knowledge of the species (table 43). This reason accounted for more than half of all the changes observed in the Canada ranks. Taxonomic changes, biological changes, and changes due to new COSEWIC detailed assessments also accounted for an important part of the reasons of the changes.

Table 42. Changes (*n* = 626) in the level of risk for species in taxonomic groups that were reassessed in the *Wild Species* 2010 report.

Taxonomic group	Number of species with increased level of risk	Number of species with reduced level of risk	Number of species changed from/to ranks 5, 6, 7, or 8*	Number of new species	Number of deleted species
Vascular plants	54	132	84	131	94
Freshwater mussels	4	1	2	0	1
Odonates	1	14	6	3	1
Tiger beetles	3	1	0	1	0
Butterflies	3	13	3	11	2
Crayfishes	0	0	0	0	0
Amphibians	1	1	0	1	0
Reptiles	4	1	0	1	0
Birds	23	1	4	12	1
Mammals	2	2	3	2	2
TOTAL	95 (15%)	166 (27%)	102 (16%)	162 (26%)	101 (16%)

* Note: 5 = Undetermined, 6 = Not Assessed, 7 = Exotic, 8 = Accidental.

Table 43. Summary of the reasons for changes in the status of species between the last assessment and the current report.

Code	Description	Number of species	Proportion of all changes
B	Change due to biological change in species' population size, distribution or threats.	63	10%
C	Change due to new COSEWIC assessment.	64	10%
E	Change due to error in previous ranks.	10	2%
I	Change due to improved knowledge of the species.	343	54%
P	Change due to procedural changes.	16	3%
T	Taxonomic change.	130	21%
	TOTAL	626	100%

Next steps and strategic orientations

The vision of the *Wild Species* series is of a single platform for wild species assessment and monitoring: a tool that allows a wide variety of species from all regions of Canada to be ranked under the same system. This allows everyone from the resource manager to the high school student the ability to place a species in a geographic, taxonomic, and ecological context, and to gain an impression of the species' general status in that context. The report *Wild Species* 2010 has contributed to this goal by increasing the number and variety of species assessed by the general status program, and by providing updated ranks for species first assessed in previous reports. However, the *Wild Species* series is a product of an ongoing, national program and the next report will aim to include an even broader diversity of species. Priorities for the future of the *Wild Species* series include:

• **Increase the number and variety of species assessed.** The *Wild Species* 2010 report, by providing the results of the assessment of 11 950 species, is one of the most important in term of number of species studied. Still, this represents only about 17% of the species known to reside in Canada! The vast majority of species left to be assessed are insects and other invertebrates. To date, the general status program has focused on groups for which experts and information are fairly readily available. However, as the program delves deeper into lesser known taxonomic groups, information will be less readily available and the process of assessing Canada's wild species will become even more challenging. Nevertheless, the benefits of assessing these lesser known taxonomic groups will be enormous. In preparation of the next report, *Wild Species* 2015, the National General Status Working Group is planning to include other lesser known taxonomic groups that will be assessed for the first time.

• **Continue to update general status assessments.** Updating general status assessments has two benefits. Firstly, it allows the incorporation of new data and new data sources, to maintain the best possible estimate of species' status. Secondly, periodically updating general status assessments will allow Canadians to track patterns of improvement or decline in species' status through time. Such patterns not only give a better indication of the nature and magnitude of a problem, but also may point the way to improved conservation practices. In preparation of the next report, *Wild Species* 2015, the National General Status Working Group is planning to reassess the taxonomic groups that were already included in the previous *Wild Species* reports.

There are many potential ways on how the *Wild Species* reports could be used. We present here five strategic orientations that identify the potential uses of the report:

• **Species at Risk Act.** Under the federal *Species at Risk Act* (SARA), a general report on the status of wildlife in Canada must be prepared every five years and be made available to the public on the SARA public registry. The *Wild Species* reports represent the main sources of information used to fulfill this engagement. The next SARA report will portray a summary of the results obtained in the *Wild Species* 2010 report.

• **COSEWIC.** The species that are ranked as May Be At Risk by the National General Status Working Group in the *Wild Species* reports can be used directly by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in prioritizing species for detailed status assessments. This category flags the species that need more attention because of possible conservation concerns.

• **Strategy on exotic species.** The species that are ranked as Exotic by the National General Status Working Group in the *Wild Species* reports could be used in a national strategy about exotic species. For example, in the *Wild Species* 2010 report, we flag that 24% of the vascular plants in Canada are Exotic species. Our report can thus be a good source to identify the taxonomic groups that have the greatest proportion of exotic species and can also be used to build a list of exotic species in Canada (for the taxonomic groups that were assessed).

• **Lack of knowledge.** In the *Wild Species* 2010 report, data were lacking for some species in some regions (Not Assessed), or the data were insufficient to allow a confident assessment of the species' general status to be made (Undetermined). It is hoped that the *Wild Species* series will continue to raise the profile of existing data gaps and stimulate people either to contribute data for these species, or to collect new data to address these shortfalls. In particular, it is hoped that the *Wild Species* series will stimulate more basic survey work on the distribution and abundance of Canadian species. The list of taxonomic groups indentified by the National General Status Working Group with a lack of knowledge can be used to flag the groups that need more research and funding efforts.

• **Sustainable development strategy.** The changes in species status over time and the proportion of species ranked as Secure could also probably serve as Canadian environmental sustainability indicators, more specifically for wildlife conservation.

The *Wild Species* series highlights both the wealth of knowledge we have about Canada's wild species, and the information gaps that need to be filled. In the future, the *Wild Species* series will continue to consolidate our knowledge of wild species by using information from experts, both amateurs and professionals, to create a baseline for comparison of the status of Canada's species. We hope that people will be encouraged by the release of these reports to contribute data on their own, or to become involved with general status assessments in their province or territory. If you want to help in the effort to collect information on Canada's species, see Appendix 1.

Human impacts upon natural systems can be complex, subtle, and ongoing and large scale, long-term programs, like the *Wild Species* series, are essential in understanding exactly what these impacts are. Future reports will continue to require long hours from experts across the country, but this effort is a small price to pay to help sustain Canada's majestic natural heritage.

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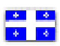
Quebec 

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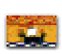
New Brunswick 

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Text: Janet Marsh.

Mosses
Leader: Gordon Court.
Main expert: René J. Belland, Ph.D.
Other experts: Bruce Bagnell, Sean Blaney, Bernard DeVries, Jennifer Doubt, Jean Faubert, Chris Friesen, Derrick Ko-Heinrichs and Michele Piercey-Normore, Ph.D.
Text: René J. Belland, Ph.D.

Vascular plants
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Main expert: Marilyn Anions.
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Molluscs – Freshwater mussels
Leaders: Rémi Hébert, Ph.D., and James Kristmanson.
Main expert: James Kristmanson.
Other experts: Becky Cudmore, Colin Jones, Donald McAlpine, Dwayne Sabine and Don Sutherland.

Spiders
Leaders: Marilyn Anions and Syd Cannings.
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Other experts: Joey Bowden, Benoit Godin, Colin Jones, Brian Latham and Don Sutherland.
Text: Robb Bennett, Ph.D.

Insects – Odonates
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Main expert: Leah Ramsay.
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Insects – Predaceous diving beetles
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Main expert: James R. Duncan, Ph.D.
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Other experts: Benoit Godin, Colin Jones, Rob Roughley, Dwayne Sabine and Don Sutherland.
Text: Henri Goulet, Ph.D.

Insects – Lady beetles
Leader: Syd Cannings.
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Other experts: Colin Jones and Don Sutherland.
Text: David McCorquodale, Ph.D.

Insects – Bumblebees
Leader: Syd Cannings.
Main expert: Sheila Colla.
Other experts: Colin Jones, Cory Sheffield, Ph.D., and Don Sutherland.
Text: Sheila Colla.

Insects – Black flies
Leader: Syd Cannings.
Main expert: Doug Currie, Ph.D.
Other experts: Terry Galloway, Ph.D, Colin Jones and Don Sutherland.
Text: Doug Currie, Ph.D.

Insects – Horse flies
Leader: Syd Cannings.
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Other experts: Terry Galloway, Ph.D., Colin Jones, Don Sutherland and Anthony Thomas.
Text: Syd Cannings.

<u>Insects – Mosquitoes</u>
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Other experts: Peter Belton, Brett Elkin, Ph.D., Terry Galloway, Ph.D., Colin Jones, Don Sutherland and Richard Westwood, Ph.D.
Text: Aynsley Thielman.

<u>Insects – Selected macromoths</u>
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Other experts: Cris Guppy, Colin Jones, Don Lafontaine, Andre Langlois, Maria Leung, Gregory Pohl, Don Sutherland and Jenny Tucker.
Text: Gregory Pohl.

<u>Insects – Butterflies</u>
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<u>Crustaceans – Crayfishes</u>
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Main expert: James Kristmanson.
Other experts: Colin Jones, Donald McAlpine and Don Sutherland.

<u>Amphibians</u>
Leader: Michael Oldham.
Main expert: Michael Oldham.
Other experts: Danny Allaire, Danny Beaulieu, Syd Cannings, Cameron Eckert, Susan Fleck, Mike Fournier, Scott Gilbert, Manfred Hoefs, Thomas Jung, Piia Kukka, Maria Leung, Donald McAlpine, Randi Mulder, Mark O’Donoghue, Don Reid, Danna Schock, Ph.D., Brian Slough and Carmen Wong.

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Mammals
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Main experts: Thomas Jung and James Kristmanson.
Other experts: Jan Adamczewski, Danny Allaire, Marsha Branigan, Syd Cannings, Suzanne Carriere, Ph.D., Dean Cluff, Cameron Eckert, Graham Forbes, Robert Gau, Scott Gilbert, Anne Gunn, Ph.D., Lois Harwood, Manfred Hoefs, Colin Jones, Allicia Kelly, Piia Kukka, Nicolas Larter, Ph.D., Cori Lausen, Ph.D., Maria Leung, Donald McAlpine, Randi Mulder, Robert Mulders, John Nagy, Mark O’Donoghue, Richard Popko, Don Reid, Dwayne Sabine, Brian Slough, Don Sutherland, Alasdair Veitch, Judy Williams, Joanna Wilson and Carmen Wong.

Many people were consulted over the course of the assessments; we apologize if someone was inadvertently omitted. The National General Status program relies on the efforts of numerous volunteers who are involved in data collection, provide their personal data for consideration during general status assessments, and participate in regional and national roll-ups. We wish to thank everyone who has volunteered their time for the National General Status program, without whom this work would not be possible.

Appendix 3 – Regional websites

Yukon
http://www.environmentyukon.gov.yk.ca/wildlifebiodiversity/speciesrisk.php
(Accessed February 23, 2010).

Northwest Territories
http://www.enr.gov.nt.ca/_live/pages/wpPages/Home.aspx
(Accessed February 23, 2010).

Nunavut
http://www.gov.nu.ca/env/
(Accessed February 23, 2010).

British Columbia
http://www.env.gov.bc.ca/atrisk/
(Accessed February 23, 2010).

Alberta
http://srd.alberta.ca/BioDiversityStewardship/SpeciesAtRisk/Default.aspx
(Accessed February 23, 2010).

Saskatchewan
http://www.biodiversity.sk.ca
(Accessed February 23, 2010).

Manitoba
http://web2.gov.mb.ca/conservation/cdc/
(Accessed February 23, 2010).

Ontario
http://nhic.mnr.gov.on.ca/
(Accessed February 23, 2010).

Quebec
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