

Threats to Endangered Species in Canada

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We quantified the threats facing 488 species in Canada, categorized by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) as extinct, extirpated, endangered, threatened, or of special concern. Habitat loss is the most prevalent threat (84%), followed by overexploitation (32%), native species interactions (31%), natural causes (27%), pollution (26%), and introduced species (22%). Agriculture (46%) and urbanization (44%) are the most common human activities causing habitat loss and pollution. For extant species, the number of threats per species increases with the level of endangerment. The prevalence of threat types varies among major habitats, with overexploitation being particularly important, and introduced species particularly unimportant, for marine species. Introduced species are a much less important threat in Canada than in the United States, but the causes of endangerment are broadly similar for Canadian and globally endangered species.

Keywords: endangered species, threats, habitat loss, introduced species, pollution

Anthropogenic activities are altering the natural world at an unprecedented scale, causing global extinction rates to rise by an estimated three or four orders of magnitude (Pimm et al. 1995, May and Tregonning 1998). A worldwide effort to slow or stop this loss of biodiversity is under way, including identification of biodiversity "hotspots" (Myers N et al. 2000, Roberts et al. 2002), development of a global protected area network (Rodrigues et al. 2004a, 2004b), prevention of the spread of exotic species (Myers JH et al. 2000, Pimentel et al. 2000, Blackburn and Duncan 2001), and reduction of overexploitation (Bodmer et al. 1997, Rosser and Mainka 2002, Brashares et al. 2004).

Information about which species are at risk and what factors threaten their existence is of central importance to planning a successful strategy to slow the loss of the world's biota. Numerous studies have investigated the threats to endangered species in the United States (Czech and Krausman 1997, Flather et al. 1998, Wilcove et al. 1998). Collectively, they identify habitat loss, followed by introduced species, as the most common cause of endangerment. It appears, however, that there is strong geographic variation in the causes of endangerment. For instance, in China, overexploitation, not habitat loss, is the major threat to endangered vertebrates (Yiming and Wilcove 2005). Furthermore, most of the world's imperiled amphibians are declining for unknown reasons, probably related to disease and climate change (Stuart et al. 2004). Given such regional variation in patterns of threat, a national conservation strategy needs to be informed by analyses conducted at a national level, recognizing that not all species on national lists will be endangered globally.

The Canadian parliament recently passed the country's most important endangered species legislation, the Species at Risk Act (SARA). Under SARA, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is charged with producing, updating, and maintaining an official list of species at risk of extinction in Canada. Species assessed by COSEWIC are reviewed by the minister of the environment before being granted protection under SARA. But although work is under way to identify Canada's endangered species, until now no attempt has been made to quantify the threats facing these species, with one notable exception: Kerr and Cihlar (2004) used remote sensing data to correlate agriculture and agricultural pollution with endangered species density in Canada. However, this analysis was unable to assess the importance of other threats, such as nonagricultural forms of habitat loss and pollution, introduced species, overexploitation, native species interactions, and natural causes.

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Here we quantify the major threats to Canada's endangered species. We categorize these causes of endangerment at a broad scale to illustrate general trends and to investigate whether the threats differ among major taxonomic groups or habitat types. We use finer-scale categories of habitat loss and pollution, divided into functional categories of human activity (agriculture, extraction, urbanization, infrastructure, and human disturbance), to determine the ultimate causes of species endangerment. Finally, we compare the causes of endangerment in Canada with those in the United States (Wilcove et al. 1998) and worldwide (Baille et al. 2004).

Data source and collection

Data on the threats (also called "causes of endangerment") to Canada's extinct, extirpated, endangered, threatened, and special-concern species (hereafter referred to simply as "endangered") were gathered from COSEWIC (2006). Following COSEWIC's definition, we considered a "species" to be any indigenous species, subspecies, variety, or genetically or geographically distinct population of wild flora or fauna. Data were gathered in June 2005, at which time COSEWIC had identified 500 endangered species from 12 taxa: vascular plants, freshwater fishes, birds, terrestrial mammals, reptiles, marine mammals, molluscs, amphibians, lepidopterans, marine fishes, mosses, and lichens (table 1).

Information provided by COSEWIC was gathered from three sources: (1) COSEWIC species status reports, (2) COSEWIC species executive summaries, and (3) the Canadian Wildlife Service (CWS). COSEWIC status reports and executive summaries are written by independent authors and reviewed by COSEWIC's Species Specialist Groups. As part of its work on species at risk, the CWS (2006) summarizes the original COSEWIC reports. When the authors of a report identified a threat as "potential" or "hypothetical," we did not include it as a known threat. We made no attempt to differentiate between historical and current threats, nor between major and minor threats, as this information was almost always unavailable. We were able to gather data on the threats facing 488 endangered species (98%). Of the remaining 12 species, 8 had only hypothetical or potential threats, and 4 had no identified threats.

Following the threat categories recognized by IUCN (World Conservation Union), we grouped the threats to endangered species into six broad categories: habitat loss, introduced species, overexploitation, pollution, native species interactions, and natural causes (table 2). To provide a more detailed account of the threats to Canada's endangered species, these categories were further subdivided (table 3); this was possible for 398 of the 488 species included in this study.

COSEWIC status reports are the best source of information on the threats to Canada's endangered species. However, these reports have at least two limitations. First, the authors may have biases toward listing some threats over others, biases that may differ between taxa or major habitat types. Second, although COSEWIC compiles and analyzes the best available data for each species, its sources are often not of an

experimental or even a quantitative nature. We can make no assumptions about how these limitations have influenced our findings.

A one-way analysis of variance (ANOVA) was used to test whether the average number of threats per species differed among levels of endangerment. Chi-squared tests were used to test for differences in the frequency of the broadscale threats among habitat types, between Canada and the world, and between Canada and the United States. In general, alpha was set at 0.05 for two-tailed tests, but was corrected to 0.007 using the Bonferroni method when comparing each broadscale threat between Canada and the world, and to 0.01 when comparing Canada and the United States. All analyses were done using SPSS 7.0 (SPSS 1997).

Threats to endangered species

Habitat loss, affecting 84% of species, is the greatest threat to endangered species in Canada (figure 1). Introduced species (22%), overexploitation (32%), pollution (26%), native species interactions (31%), and natural causes (27%) all affect much smaller proportions of species. Surprisingly, pollution and introduced species, both of which are widely believed to be major causes of species endangerment (Wilson 1992), are less important than either native species interactions or natural causes, neither of which are even listed as potential threats in similar studies (Wilcove et al. 1998).

Few species (30%) are threatened by only a single cause of endangerment. On average, endangered species face 2.2 of the 6 broadscale threats. The number of threats facing a species varies significantly among levels of endangerment (ANOVA: $F_{(3,484)} = 5.79, p = 0.001$), increasing from special concern to threatened to endangered species (1.99, 2.22, and 2.44, respectively). The combined category of extinct and extirpated species has the fewest threats (1.94). Because 57% of extinct and extirpated species have not been sighted in the past 50 years (COSEWIC 2006), the paucity of identified threats for these species is most likely attributable to our lack of knowledge.

The relative importance of a threat type varies strongly among taxa (table 3). While habitat loss is important for all taxa, it is much less of a threat to freshwater fishes, marine fishes, and marine mammals. Overexploitation is the most prevalent threat for marine mammals and marine fishes (affecting 88% and 94%, respectively) and is also an important threat for reptiles and terrestrial mammals (affecting 65% and 47%, respectively). Pollution is the second-ranked threat for freshwater fishes (51%) and also threatens a similar proportion of amphibians (53%). Like Richter and colleagues (1997), we found that nonpoint sources (e.g., siltation and nutrient inputs) are the most common form of freshwater pollution. Native species interactions are the second most important threat for birds (46%), terrestrial mammals (47%), and lichens (57%). Natural causes are the second most important threat for amphibians, affecting 58% of species. Over half of Canada's endangered amphibians are found only in the southern part of the country, within 100 kilometers of the US

Table 1. The number of species in each taxon listed as extinct, extirpated, endangered, threatened, or of special concern by the Committee on the Status of Endangered Wildlife in Canada, June 2005.

Taxon	Extinct species	Extirpated species	Endangered species	Threatened species	Species of special concern	Total listed species	Species listed as facing threats
All species	13	22	184	129	152	500	488
Vascular plants	0	2	74	48	35	159	151
Freshwater fishes	6	3	18	18	32	77	77
Birds	3	2	24	10	22	61	61
Terrestrial mammals	1	2	9	8	16	36	36
Reptiles	0	4	8	13	9	34	34
Marine mammals	1	2	9	9	12	33	32
Molluscs	1	2	12	2	4	21	21
Amphibians	0	1	6	5	7	19	19
Lepidopterans	0	3	8	6	2	19	19
Marine fishes	0	0	8	6	4	18	18
Mosses	1	1	6	3	4	15	13
Lichens	0	0	2	1	5	8	7

Table 2. Definitions of broadscale and fine-scale threat categories.

Threat	Definition
Habitat loss	Reduction or degradation of required habitat
Urbanization	Development of human settlements (urban, suburban and, rural) and industrial and commercial buildings
Agriculture	Crops, wood plantations, nontimber plantations, livestock (including ranching), aquaculture
Human disturbance	Recreation/tourism, military activities, research, transport, vehicle and vessel traffic
Extraction	Logging, mining, fishing, groundwater, oil and gas, aquifer depletion
Infrastructure	Transportation, telecommunications, power lines, dams, impoundments, water diversions, pipeline construction
Introduced species	Competition, predation, hybridization, infection, habitat modification by introduced species ^a
Overexploitation	Intentional or unintentional harvest or persecution
Pollution	Chemical, thermal or acoustic pollution, turbidity, and sedimentation
Native species interactions	An increase or decrease in a species' native competitors, predators, pathogens, prey, symbionts, or other organisms with which it interacts
Natural causes	Any stochastic event (e.g., storm, drought, or fire) or factor inherent to the species (e.g., limited dispersal, narrow niche)

a. Cultivated species on farms and species native to Canada that had expanded or shifted their range were not considered.

border (COSEWIC 2006); Canada may represent the northern edge of these species' range. This probably makes them especially susceptible to natural causes of endangerment, which include such factors as severe weather and inherent biological limitations.

The fine-scale threat categories in table 3 provide more detailed information on the threats facing Canada's endangered species. Urbanization (28%) and agriculture (27%) are the most common causes of habitat loss. Competition (10%) and predation (6%) are the major mechanisms by which introduced species endanger native species. Intentional harvest (22%), followed by bycatch (9%), is the most important form of overexploitation. As with the broadscale categories, these trends vary greatly among taxa. Human disturbance, typically some form of recreational activity, is the greatest cause of habitat loss for vascular plants, affecting 42% of species. Bycatch, affecting an astonishing 78% of endangered marine fish, is the most important cause of overexploitation for these taxa, whereas road kills (41%) are one of the most important threats for reptiles.

Threats by habitat type

To determine whether the prevalence of threat types varies among habitats, we grouped species by their primary habitat and compared the threats facing these groups. We attempted to define each of the 488 endangered species with threat data as being primarily a terrestrial, freshwater, or marine species. To do this, we gathered information about habitat use for each species from Wright and Wright (1957), Scott and Crossman (1973), Wheeter (1975), Straley and colleagues (1985), Godfrey (1986), Argus and colleagues (1987), Banfield (1987), Gleason and Cronquist (1991), Behler and King (1998), COSEWIC (2006), and CWS (2006). Sixty species commonly used more than one habitat type and were therefore excluded from the analysis, including 16 birds, 13 amphibians, 9 reptiles, 5 marine mammals, 4 freshwater fishes (anadromous), 5 marine fishes (anadromous), 4 terrestrial mammals, and 4 vascular plants. Of the remaining 428 species, 231 were defined as terrestrial, 154 as freshwater, and 43 as marine.

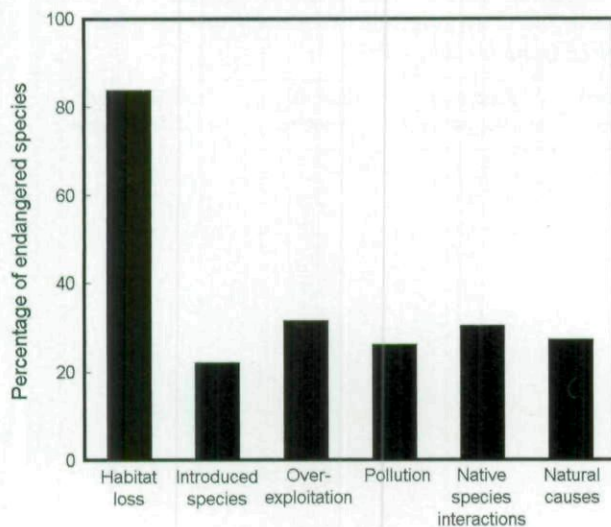


Figure 1. The percentage of endangered species in Canada ($n = 488$) identified by the Committee on the Status of Endangered Wildlife in Canada in June 2005 as threatened by habitat loss, introduced species, over-exploitation, pollution, native species interactions, or natural causes.

The relative importance of the six major threat categories differs significantly among habitat types (figure 2; $\chi^2 = 127.42$, degree of freedom [df] = 10, $p < 0.001$). Habitat loss is the major cause of endangerment in terrestrial (94%) and freshwater (79%) habitats, whereas overexploitation is the major cause in marine habitats (88%). The second most important threat in the terrestrial habitats is native species interactions (35%), whereas pollution is the second most common threat in freshwater habitats (45%). Habitat loss is the second most important threat (50%) in oceans, primarily because vessel traffic degrades habitats for marine mammals and commercial fishing damages benthic habitats for fishes and invertebrates. Affecting only 3% of marine species, introduced species seem to be an infrequent threat in the marine environment, presumably because the long-distance dispersal that often occurs in oceans means that oceans have fewer endemic species than do terrestrial habitats (Davis 2003).

Ultimate causes of species endangerment

Here we attempt to link human activities, the ultimate causes of endangerment, to the proximate causes of endangerment shown in table 3. The proximate threats of habitat loss and pollution—habitat degradation—affect 453 (93%) of Canada's endangered species. We divided the causes of these threats into five functional categories of human activity: urbanization, agriculture, human disturbance, extraction, and infrastructure. In total, there was sufficient information to determine the sources of habitat degradation for 341 species.

Agricultural activity (46%) and urbanization (44%) are the most prevalent ultimate causes of endangerment in Canada. Surprisingly, human disturbance (35%) is a more common

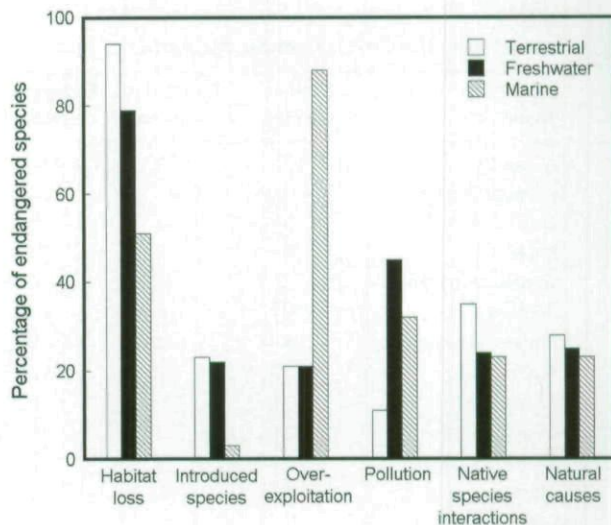


Figure 2. The percentage of Canadian terrestrial ($n = 231$), freshwater ($n = 154$), and marine ($n = 43$) endangered species that are listed by the Committee on the Status of Endangered Wildlife in Canada as threatened by habitat loss, introduced species, overexploitation, pollution, native species interactions, or natural causes.

cause of habitat degradation than either extraction (33%) or infrastructure development (28%). The most commonly cited forms of human disturbance were vessel traffic for marine animal species and either all-terrain vehicle use or pedestrian trampling for many terrestrial plant species.

Kerr and Cihlar (2004) found that land use is an excellent predictor of endangered species density in Canada. However, their land-use data included information on agricultural activity but not on urbanization, human disturbance, extraction, or infrastructure. In our analysis, the relative importance of these nonagricultural categories of land use as a cause of endangerment is surprising. A possible explanation may be that urbanization, agriculture, human disturbance, extraction, and infrastructure development are highly associated causes of endangerment in space (Czech et al. 2000). Hence it may be difficult to conclude from remote sensing data whether it is agricultural activity alone or one of its associated threats, or both, that is actually endangering species.

Comparisons with the world

We compared the threats facing endangered species in Canada with the threats facing globally endangered species, using data from Baille and colleagues (2004). Summarizing data provided by IUCN, Baille and colleagues (2004) catalogued the threats facing 3829 globally endangered species of amphibians, birds, and mammals. When comparing our results with theirs, we included only these three taxa ($n = 148$). In their analysis, Baille and colleagues (2004) identified 10 broad threat categories. To permit comparison with our study, we combined their category "human disturbance" with "habitat loss." We also combined "persecution" and "incidental mor-

Table 3. Summary of the threats facing endangered species in Canada, expressed as the percentage of endangered species affected.

Threat	All species (n = 488)	Vascular plants (n = 151)	Freshwater fishes (n = 77)	Birds (n = 61)	Terrestrial mammals (n = 36)	Reptiles (n = 34)	Marine mammals (n = 32)	Molluscs (n = 21)	Amphibians (n = 19)	Lepidopterans (n = 19)	Marine fishes (n = 18)	Mosses (n = 13)	Lichens (n = 7)
Habitat loss	83.8	94.0	67.5	86.9	83.3	94.1	50.0	85.7	94.7	94.7	66.7	92.3	85.7
Urbanization	27.9	37.7	15.6	21.3	36.1	50.0	6.3	33.3	31.6	15.8	5.6	30.8	14.3
Agriculture	27.3	29.8	9.1	41.0	58.3	41.2	0	29.0	26.3	15.8	11.1	38.5	0
Human disturbance	24.6	41.7	10.4	14.8	19.4	11.8	43.8	19.0	5.3	10.5	16.7	23.1	28.6
Extraction	20.5	25.8	3.9	26.2	30.6	14.7	6.3	14.3	26.3	5.3	44.4	15.4	71.4
Infrastructure	18.0	19.9	18.2	8.2	22.2	32.4	9.4	14.0	36.8	0	22.2	23.1	0
Introduced species	22.1	32.5	27.3	14.8	11.1	17.6	0	28.6	36.8	15.8	16.7	0	0
Competitors	9.6	20.5	7.8	1.6	2.8	2.9	0	9.5	15.8	0	11.1	0	0
Predators	5.9	1.3	14.3	9.8	2.8	11.8	0	0	21.1	0	5.6	0	0
Hybridizers	1.8	2.0	2.6	0	5.6	0	0	0	0	0	0	0	0
Pathogens	0.8	0.7	0	0	5.6	0	0	5.3	0	0	0	0	0
Habitat effect	3.7	4.0	0	4.9	2.8	2.9	0	0	15.8	15.8	5.6	0	0
Overexploitation	31.6	11.3	33.8	34.4	47.2	64.7	87.5	9.5	10.5	10.5	94.4	0	0
Harvesting	22.1	11.3	19.5	24.6	25.0	29.4	78.1	9.5	5.3	5.3	72.2	0	0
Bycatch	9.2	0	11.7	4.9	8.3	11.8	34.4	0	0	5.3	77.8	0	0
Road kill	4.9	0	0	9.8	8.3	41.2	0	0	5.3	0	0	0	0
Persecution	3.9	0	2.6	0	16.7	32.4	0	0	0	0	0	0	0
Collisions	3.1	0	0	8.2	0	5.9	25.0	0	0	25.0	0	0	0
Pollution	26.2	12.6	50.6	29.5	13.9	17.6	43.8	42.9	52.6	0	27.8	7.7	28.6
Agriculture	9.2	3.3	11.7	13.1	11.1	2.9	6.3	42.9	26.3	0	5.6	0	14.3
Urbanization	5.9	4.0	11.7	1.6	2.8	8.8	12.5	24.0	0	0	0	0	0
Extraction	4.1	0	2.6	4.9	0	2.9	18.8	14.0	10.5	0	16.7	0	0
Infrastructure	2.7	2.6	1.3	1.6	0	0	12.5	9.5	5.3	0	0	0	0
Human disturbance	0.2	0	0	0	0	0	0	4.8	0	0	0	0	0
Native species interactions	30.5	31.8	16.9	45.9	47.2	35.3	21.9	28.6	21.1	21.1	27.8	7.7	57.1
Natural causes	27.3	26.5	15.6	24.6	30.6	50.0	6.3	28.6	57.9	26.3	38.9	30.8	42.9
Intrinsic factors	14.8	11.3	7.8	8.2	11.1	38.2	3.1	24.0	52.6	15.8	38.9	7.7	0
Natural disasters	14.3	16.6	9.1	18.0	22.2	11.8	6.3	4.8	15.8	10.5	5.6	23.1	42.9

Note: Categories are not exclusive and therefore do not sum to 100%.

tality" with "overexploitation." In our study, when a pathogen was not identified as being introduced, it was assumed to be native and included as "species interactions." To match our study, we combined Baillie and colleagues' (2004) "disease" and "changes in native species dynamics" to form "species interactions." Finally, we retained only "natural disasters" from our original category "natural causes."

The prevalence of threat types differs significantly between Canadian and globally endangered species (figure 3; $\chi^2 = 38.42$, $df = 5$, $p < 0.001$). While habitat loss is the most prevalent threat both in Canada (79%) and globally (87%), it affects a slightly greater proportion of globally endangered species ($\chi^2 = 7.865$, $df = 1$, $p = 0.005$). Introduced species affect a similarly small proportion of Canadian (14%) and global species (16%; $\chi^2 = 0.47$, $df = 1$, $p = 0.49$). Overexploitation threatens significantly more endangered species in Canada than globally (46% and 23%, respectively; $\chi^2 = 43.68$, $df = 1$, $p < 0.001$). The differential importance of overexploitation in the two studies can largely be explained by the relative importance of the three taxa in the two studies. Baillie and colleagues' (2004) study included proportionately more amphibians and fewer mammals than did our study. If we adjust our taxa to the same relative frequency as those in Baillie and colleagues' (2004) study, there is no significant difference in the importance of overexploitation to Canadian (26%) and globally (24%) endangered species ($\chi^2 = 0.815$, $df = 1$, $p = 0.367$). Natural disasters affect significantly more endangered species in Canada than globally (16% and 9%, respectively; $\chi^2 = 8.86$, $df = 1$, $p = 0.003$), perhaps because many of Canada's endangered species exist at the northern edge of their range (Bunnell et al. 2004, Warman et al. 2004) and are therefore more susceptible to severe weather events.

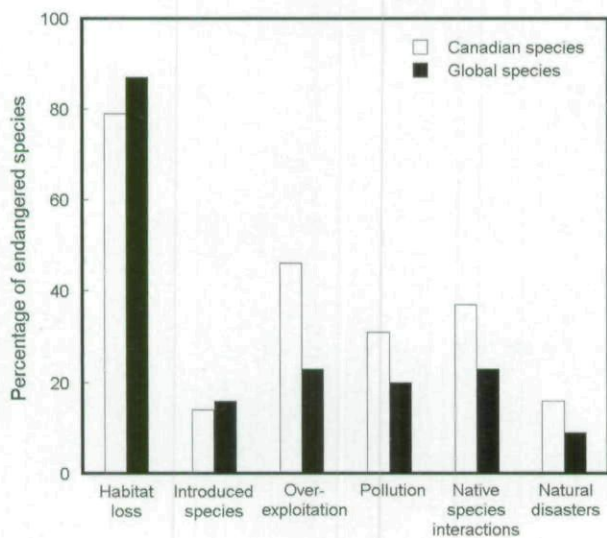


Figure 3. The percentage of endangered species in Canada ($n = 148$) and worldwide ($n = 3829$) that are affected by habitat loss, introduced species, over-exploitation, pollution, native species interactions, and natural disasters.

Comparisons with the United States

We compared the threats facing endangered species in Canada with those in the United States, using data from Wilcove and colleagues (1998). In their study, Wilcove and colleagues cataloged the threats facing 1880 imperiled species, subspecies, and populations of vertebrates, invertebrates, and plants. However, their categories of threat differed from ours; they did not include native species interactions and natural causes as potential threats, but instead included disease, which was found to affect only 3% of species. To permit direct comparison between the two studies, these categories were excluded.

Habitat loss and introduced species are the leading threats to imperiled species in the United States, affecting 89% and 49% of species, respectively (figure 4). While habitat loss is equally important in both countries ($\chi^2 = 0.42$, $df = 1$, $p = 0.52$), the importance of introduced species as a cause of endangerment in the United States contrasts strongly with our results, which identify introduced species as the least common broadscale threat in Canada ($\chi^2 = 113.74$, $df = 1$, $p < 0.001$). We believe the heightened importance of introduced species in the United States can be explained by the large number of Hawaiian species included in Wilcove and colleagues' (1998) analysis and the widespread effects of introduced species on the islands. For instance, the authors included 456 Hawaiian plants and birds, of which 99% were threatened by introduced species. Excluding Hawaiian species, the importance of introduced species did not differ significantly between the United States (31%) and Canada (27%) for plants and birds, the only taxa for which data are available ($\chi^2 = 1.22$, $df = 1$, $p = 0.27$).

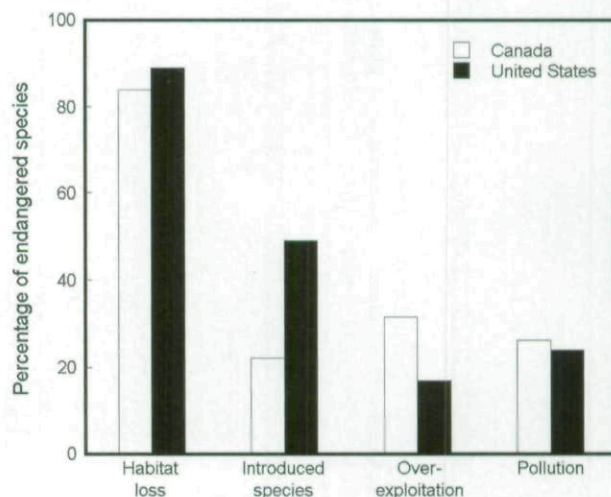


Figure 4. The percentage of Canadian ($n = 488$) and US ($n = 1880$) endangered species that are affected by habitat loss, introduced species, overexploitation, and pollution.

Aside from disease, Wilcove and colleagues (1998) found overexploitation to be the least important threat in the United States, affecting only 17% of imperiled species (figure 4). This contrasts strongly with Canada, where we found 32% of species to be threatened by overexploitation ($\chi^2 = 51.13$, $df = 1$, $p < 0.001$). While this discrepancy may be due in part to real differences between the two countries, we believe it is largely attributable to the definition of overexploitation. Wilcove and colleagues (1998) included only overharvest, to the exclusion of bycatch, persecution, and accidental mortality. Redefining our category for consistency with theirs, we find that overharvest threatens only a slightly higher proportion of endangered species in Canada than in the United States (22% and 17%, respectively; $\chi^2 = 6.83$, $df = 1$, $p = 0.009$).

Conservation implications

Our study, like others conducted elsewhere (Wilcove et al. 1998, Baille et al. 2004), showed that habitat loss is the greatest threat to endangered species in Canada. Affecting 94% of terrestrial species, habitat loss is caused primarily by agricultural and urban land conversion. The establishment of terrestrial protected areas is a common and effective response to protect species from habitat loss (Balmford et al. 1995). Unfortunately, much of the habitat used by Canada's endangered species exists on private land (Barla et al. 2000). To protect these species, landowners will need to be compensated for encouraging the persistence of endangered species on their property (Polasky et al. 1997), which is explicitly recognized in Canada's new endangered species legislation (SARA 2006). On the negative side, SARA provides less habitat protection for terrestrial species than the United States' Endangered Species Act; in Canada, critical habitat for endangered species is strictly protected only on federal lands, accounting for only 4% of the terrestrial habitat south of 60° north latitude (Scudder 1999). On the positive side, all migratory birds and aquatic species receive habitat protection under SARA. In addition, a "safety net" process can provide habitat protection for species not on federal lands.

We found that overexploitation was the second most common threat in Canada, in contrast with other researchers' findings for the United States and for the world. Moreover, overexploitation was the most important threat facing Canadian marine species. To protect these species, there is a strong initiative to establish a system of marine protected areas, both in Canada and globally (Balmford et al. 2004). Unfortunately, most analyses suggest that 20% to 30% of oceans need to be protected to sustain world fisheries in the remaining habitat (Balmford et al. 2004). This is an ambitious goal, given that only 0.5% of oceans are currently protected, compared with 11.5% of terrestrial habitats (Meir et al. 2004).

Introduced species are the least important threat in Canada. This contrasts strongly with the findings of previous studies (Wilcove et al. 1998, Clavero and Garcia-Berthou 2005) and with popular opinion (Wilson 1992). However, when Hawaiian species are excluded, introduced species are about equally

important in the United States and Canada. Furthermore, introduced species are rarely a threat to Chinese (3%; Yiming and Wilcove 2005) or globally threatened species (16%; Baille et al. 2004). It appears that introduced species may be a less important threat, at least on continents, than previously thought.

Natural disasters and natural causes emerge as more common threats in Canada than globally. This surprising result does not mean that natural processes alone are major threats to Canada's biodiversity. Of the 237 species for which either natural disasters or natural causes are listed as threats, only 15 species are threatened by no other cause. On average, these 237 species are threatened by 1.6 other broadscale threats and 2.5 other fine-scale threats.

Many endangered species in southern Canada have stable core populations in the United States (Bunnell et al. 2004, Warman et al. 2004). Emerging as a major question for conservation policy in Canada is what efforts, if any, should be made to protect these endangered peripheral populations. Peripheral populations are thought to be more susceptible to extinction and therefore harder to conserve (Hoffman and Blows 1994). However, recent studies have shown that under conditions of range contraction, core populations appear to suffer extirpation first, leaving only peripheral populations (Channell and Lomolino 2000, Laliberte and Ripple 2004). Determining the value of peripheral populations will prove critical for conservation policy in Canada.

In general, our findings present few major surprises. There are important differences in the causes of endangerment in Canada among major habitats and taxa, but many of the marked differences among regions of the world are more apparent than real. Finally, most species are affected by more than one threat, with the number of threats increasing with the level of endangerment. Effective conservation strategies must be able to address multiple threats simultaneously.

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