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National attention to endangered wildlife is not affected by global endangerment: A case study of Canada's species at risk program

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ABSTRACT

With the number of endangered species increasing and budgets for protection remaining inadequate, there is an urgent need to judiciously prioritize management. Some potential approaches include prioritizing based on threat, uniqueness (i.e., full species prioritized before subspecies) or endemicity. Here, we use Canada as a case study to test whether management under the national Species at Risk Act prioritizes endemic and globally at risk species, versus subspecies and populations of globally secure species. Canada is an ideal case study because it is a large country with many species that are at the northern edge of their ranges, but others that are globally at risk endemics. We show that Canada does a poor job of prioritizing globally at risk and endemic full species. Only a small proportion of species listed have legally required 'Action Plans' for management, and this proportion is not significantly greater for globally at risk species. In addition, reptiles, amphibians, mammals and fish are more likely to be managed as subspecies or populations compared to other taxa, possibly due to greater differentiation among populations, bias in research toward charismatic or economically-valued taxa, or to allow continuation of economic activities that threaten portions of species' habitats. Given the limited resources being allocated to conserving species at risk of extinction, we suggest that full, endemic threatened species for which host nations bear sole responsibility must be the highest priority, and that globally threatened species should also be given high priority.

1. Introduction

In the face of rapid biodiversity declines (Pimm et al., 2014; WWF, 2016), managers responsible for threatened species conservation must make difficult decisions about how to allocate their limited resources (Wilson et al., 2009). Typically, national legislation specifies that priorities for conserving threatened taxa should be set based on threat level (De Grammont and Cuaron, 2006). For example, in Canada, species that are assessed as being 'endangered' or 'threatened' are meant to be given higher priority than those with lower imperilment status. Managers are tasked with preparing a Recovery Strategy and then an Action Plan that outlines protection measures, following a legislated timetable. A similar general approach is followed in the United States, Europe, Japan, South Africa and Australia (ESA, 1973; Act on the conservation of endangered species of wild fauna and flora, 1992; EPBC Act, 1999; SARA, 2002; Biodiversity Act, 2004).

National legislation regarding biodiversity conservation typically uses "species" as the baseline taxonomic unit. Accordingly, most national extinction risk assessments and management decisions are conducted at the species level. However, national legislation often allows subspecies or populations to be used as baseline taxonomic units for conservation (e.g., ESA, 1973; Act on the conservation of endangered species of wild fauna and flora, 1992; EPBC Act, 1999; SARA, 2002; Biodiversity Act, 2004). In Canada, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) uses Designatable Units (DUs) to identify subspecies, varieties or populations of a taxonomic species that are discrete, and important to the evolutionary legacy of the species as a whole (COSEWIC, 2017). This is based on knowledge that genetically or geographically isolated subspecies or populations may be best managed as distinct entities (Vogler and Desalle, 1994; Walpes, 1995). For example, Thiemann et al. (2008) discovered that threats to the conservation of polar bears (*Ursus maritimus)* are not spatially uniform and concluded that the use of subspecies units can provide a biologically-sound framework for polar bear conservation. However, guidelines for classifying DUs are subjective, and such approaches may be subject to uncertainty and debate (Pennock and Dimmick, 1997; Walpes, 1998). For example, the lake sturgeon (*Acipenser fulvescens*) is managed at the population level in Canada (currently four Designatable Units), while in the United States the entire species is unlisted, despite the fact that many of the DUs ranges span the

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Table 1
Definitions of categories used in analysis.

Globally threatened species	A species that has an IUCN designation of Critically Endangered, Endangered or Threatened, or any full species recommended by COSEWIC that is endemic to Canada and therefore is threatened throughout its range
Endemic species	Any species that occurs exclusively in Canada. If a species was determined to be shared to any extent with another country, whether this was by an overlap in range or a species which spends part of its time outside Canada due to migration it was not considered endemic. COSEWIC assessment reports were reviewed to determine species range, and if there was any uncertainty ESA assessments were also consulted
Designatable Unit	Species, Subspecies, variety, or geographically or genetically distinct population that may be assessed by COSEWIC, where such units are both discrete and evolutionary significant
Population	As defined by COSEWIC, distinct subgroups in the Canadian population between which there is little demographic or genetic exchange
Subspecies	A designatable unit recognized as a subspecies by COSEWIC

Canada-USA border (ESA, 1973; COSEWIC, 2017; SARA, 2017).

In addition, many national conservation agencies manage species that are nationally rare but globally secure. There may be rational biological reasons for this approach. Peripheral populations at range edges may have unique local adaptations, which can allow range expansion and may provide an increased resilience to climate change (Lenormand, 2002). However, peripheral populations can also be subject to gene swamping from core populations (Kirkpatrick and Barton, 1997), preventing adaptation (Lammi et al., 1999; Hamilton and Eckert, 2007). In addition, jurisdictions may be interested in conserving biodiversity within their boundaries, rather than globally, and thus may be motivated to conserve range-edge species that are secure elsewhere.

Given limited resources, national conservation programs either implicitly or explicitly prioritize some taxa over others. For example, in New Zealand and the Australian state of New South Wales, management agencies have openly used cost-effectiveness approaches to prioritize as many species as possible (Joseph et al., 2009; Biodiversity Conservation Act, 2016). Although North American management agencies are typically mandated to prioritize based on threat level, many species that are recognized as threatened with extinction receive little or no active management (Findlay et al., 2009; Mooers et al., 2010; Evans et al., 2016), suggesting both limited resources and management bias (Mooers et al., 2010; Evans et al., 2016). Given the fact that some species are clearly being prioritized over others, it is logical that species in a jurisdiction that are globally at risk be the top priority, as their continued existence is highly dependent on effective management in this jurisdiction (Bennett et al., 2014). This is especially true for endemic threatened species, which are entirely dependent on effective management in the jurisdiction in which they are found. The concept of regional responsibility has been previously suggested as a criterion for prioritization (Schmeller et al., 2008; Gauthier et al., 2010) but has yet to be adopted into national level endangered species legislation, although some countries do emphasize protection for endemic threatened species (USFWS, 1983; Bennett et al., 2014). In Canada, COSEWIC does include these criteria when making listing and management decisions (COSEWIC, 2010), but this has not been incorporated into the national species at risk legislation.

Here, we use Canada as a case study to test the extent to which a national threatened species conservation program prioritizes globally threatened species, versus subspecies units. To do so, we partitioned listings for Canadian threatened species using two criteria: 1) full species status; and 2) global risk. We then tested these groups to examine actual national priorities, using advancement from recognition as 'at-risk' (i.e., ‘endangered’, ‘threatened’, or ‘special concern’) by the non-legal listing body (COSEWIC) to the final stage of management planning (publication of an Action Plan) as an indicator of priority. Specifically, we ask the following question: Are globally threatened species given priority over subspecies and peripheral populations of secure species? Canada is an excellent case study for a number of reasons. First, because of the country’s vast size and diverse geography, species with large ranges might often be managed as subspecies or population units, providing a larger sample size for analysis. Second, there are also sufficient endemic, globally threatened species to test whether management favours these versus other species. Assuming resources are limited, we predicted that globally threatened full species would be the top conservation priority, and therefore would have a higher proportion of Action Plans.

2. Methods

2.1. Data collection

We conducted our analysis in R using the 729 DUs (i.e., species, subspecies or populations) listed, or recommended to be listed, under SARA Schedule One, which provides legal protection and mandates recovery efforts (R Development Core Team, 2016; SARA, 2017; Table S1). To be added to Schedule One, a species first must be assessed by COSEWIC, and then can only be added to the list after recommendation by the Minister of Environment and Climate Change. For Schedule One species, management stages include production of Recovery Strategies (for endangered or threatened species) or Management Plans (for species designated as ‘special concern’), followed by Action Plans that dictate actual management. Our analysis assumes that production of an Action Plan for a species means that this species is given high priority, since Action Plans are the final planning stage, and dictate on-the-ground actions to address threats. Using information gathered from SARA (SARA, 2017), COSEWIC (COSEWIC, 2017), the International Union for Conservation of Nature (IUCN, 2016), and US ESA (ESA, 1973) websites we scored each DU for a set of eight attributes: taxonomic group, SARA classification, IUCN threat category, COSEWIC threat status category, endemicity to Canada, stage of conservation planning under SARA, whether the unit was a full species, subspecies or population and the year that unit was designated. Detailed definitions of each category can be found in Table 1. Results are reflective of data gathered as of November, 2017.

We partitioned the 729 entries using two criteria. First subspecies and population units were separated from full species units. We then further sub-divided the full species by global risk factor. A unit was considered globally threatened if it was ranked as critically endangered, endangered or threatened by the IUCN, or if it was endemic to Canada. Endemic full species not listed by the IUCN were considered to be globally threatened if they were recommended by COSEWIC because this implies they are threatened throughout their global range (see Fig. S1 for details).

2.2. Statistical analysis

To answer our primary question regarding prioritization of globally threatened species, we used Fisher’s exact tests to compare the proportions of DUs with finalized Action Plans across three categories: DUs that are subspecies and populations, full species (that are not globally threatened), and full species that are globally threatened (including endemics, which, since they are considered to be at risk in their endemic ranges, we assumed to be globally threatened). Supplemental analysis treating endemics as a separate category yielded similar results to our main analysis (see supplementary material Table S3 for details).

To determine whether some DUs were more likely than others to be managed as subspecies or populations, we compared the proportions of subspecies units for 10 taxonomic groups (Molluscs, Amphibians, Arthropods, Birds, Fish, Lichens, Mammals, Mosses, Plants, and Reptiles) versus all other groups using Fisher's exact tests. To test for potential differences within taxonomic groups in the proportions of globally threatened full species with Action Plans, we compared the proportion of DUs with Action Plans among subspecies and population DUs, full species (that are not globally threatened), and globally threatened full species for each taxonomic group using Fisher's exact tests.

3. Results

Of the 729 DUs (species, subspecies or populations) recognized as being threatened in Canada, 269 (37%) were subspecies or populations, 381 (52%) were full species that were not globally threatened, and 79 (10%) were full species considered globally threatened. Among all 729 DUs, 237 had Action Plans (33%), 128 (34%) of the full species that were not globally threatened and 31 (39%) globally threatened full species had Action Plans (34%). These proportions were not significantly different (Table S2). Fish ($p = 5.62 \times 10^{-12}$), amphibians ($p = 0.021$), reptiles ($p = 0.019$), and mammals ($p = 4.52 \times 10^{-9}$) had significantly higher proportions of subspecies DUs compared to all other taxonomic groups, while mosses ($p = 4.97 \times 10^{-4}$), vascular plants ($p = 8.5 \times 10^{-5}$) and molluscs ($p = 7.56 \times 10^{-5}$), had significantly lower proportions of subspecies DUs (Fig. 1). Vascular plants also had a lower proportion of globally threatened full species than full species that are not globally threatened, compared to other taxa ($p = 0.03$) (Fig. 1).

In each taxonomic group, the proportion of DUs with Action Plans among all units, full species, and globally threatened full species varied considerably (Fig. 2). However, only one significant difference was found, partly reflecting high levels of variability and relatively small number of units in some groups (Table S2, Fig. 2). Plants (the largest group) were the only taxonomic group to have a greater proportion of globally threatened species with Action Plans than subspecies with Action Plans (Table S2). For three taxonomic groups (amphibians, arthropods and lichens), none of the globally threatened species had Action Plans, even though they had units listed (Fig. 2).

4. Discussion

We found that in Canada, globally threatened species are not receiving higher priority than either subspecies or peripheral populations of globally secure species (Fig. 2, Table S2). Indeed, 70% of the 33 full endemic species threatened in Canada do not have an Action Plan for recovery, and 24% have no federal protection under SARA, despite being listed as species at risk by COSEWIC. The majority of these species (58%) are listed as endangered or threatened. In addition, only 45% of globally threatened non-endemics have Action Plans in Canada. Although these species may have protection in other countries, it is clear that Canada is not meeting its obligation to help prevent their extinction. These results are consistent with the Canadian listing and management criteria, which do not recognize endemicity or the global status of a species as a factor in listing and management decisions (SARA, 2002; COSEWIC, 2010). However, they indicate that several globally threatened species are without adequate federal protection, while other populations of species that are globally secure are receiving far greater attention.

There are often sound biological reasons for conserving subspecies and peripheral populations. For example, it is common for peripheral

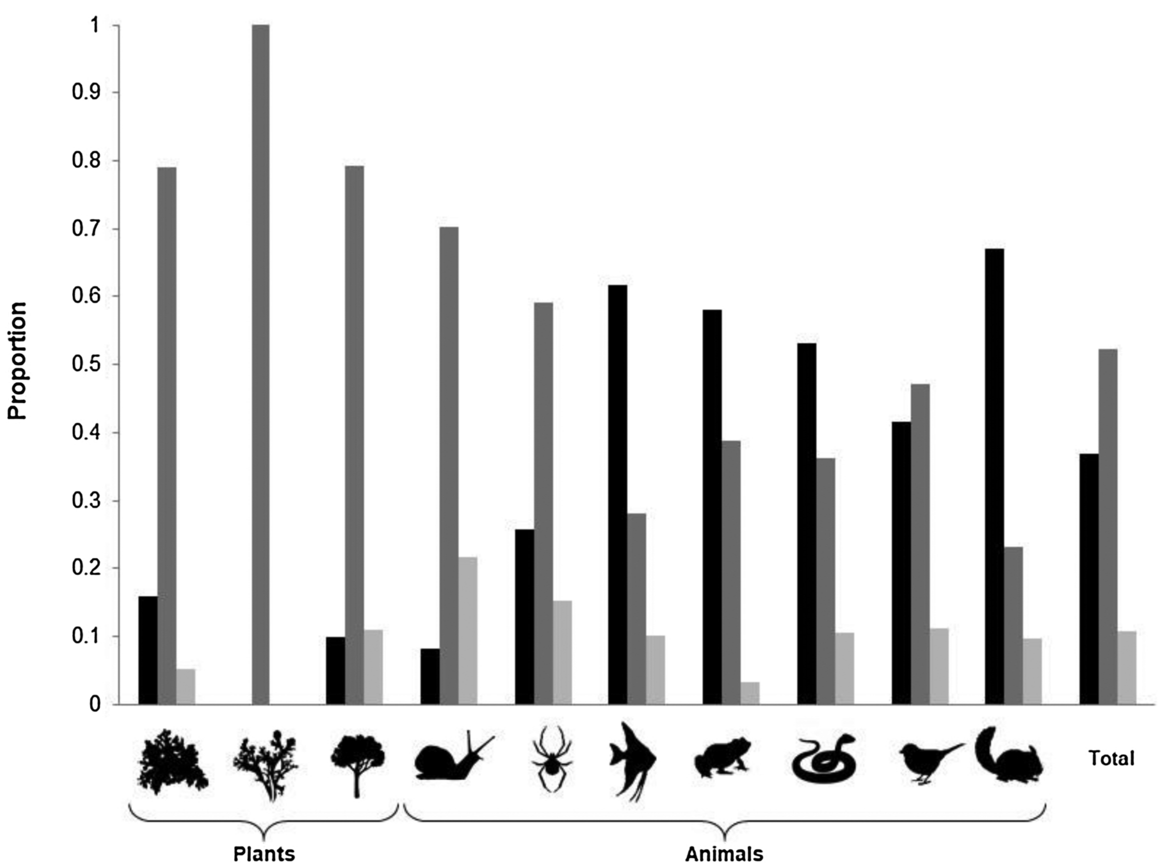

Fig. 1. Proportions of listing per taxon in different categories. Black bars represent the proportion of Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recommendations for that taxonomic group that are subspecies. Dark grey bars represent the proportion that are full species which are not globally threatened. Light Grey bars represent the proportion of globally at risk full species. Taxonomic groups (from left to right): Lichens, Mosses, Vascular Plants, Molluscs, Arthropods, Fish, Amphibians, Reptiles, Birds, Mammals, and the total across all taxa.

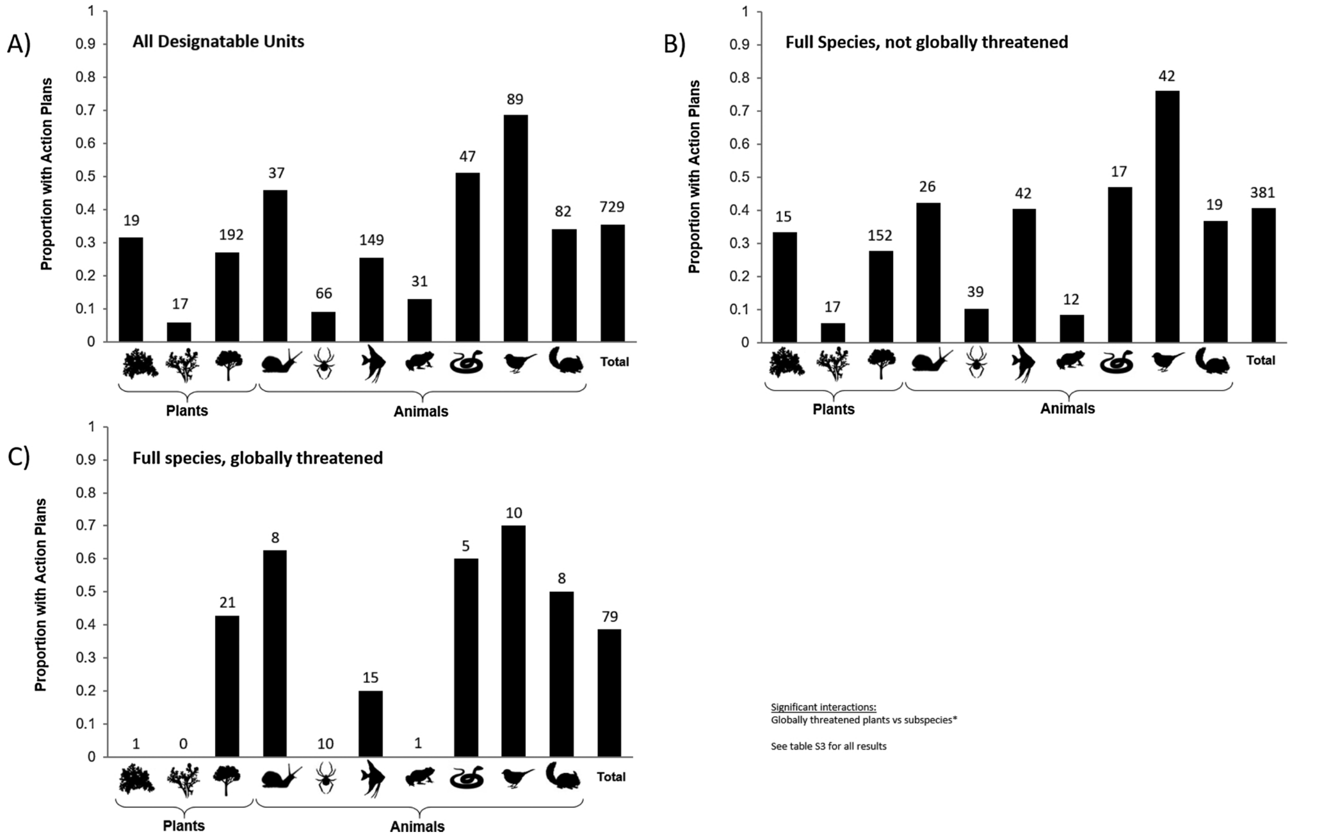

Fig. 2. a) Proportion of total DUs recommended by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) with Action Plans; b) Proportion of DUs that are full species that are not globally threatened with Action Plans; c) Proportion of DUs that are full species and globally threatened with Action Plans. Taxonomic groups in all panels (from left to right): Lichens, Mosses, Vascular Plants, Molluscs, Arthropods, Fish, Amphibians, Reptiles, Birds, Mammals, and total across all taxa. Numbers above each bar represent the total of designated units in each category.

populations to be subject to different environmental conditions than core populations, leading to diverse genetic adaptations (Lenormand, 2002). The flexibility to manage such units is integral to Canada's Species at Risk Act, and more units will likely be designated as biological knowledge increases. For example, COSEWIC has voted to increase the number of Caribou (*Rangifer tarandus*) DUs from seven to 12, since populations are thought to exhibit a high level of diversity over a wide habitat range (COSEWIC, 2011; Mee et al., 2015). Indeed, the proportion of subspecies DUs among listed taxa appears to be increasing over time (Fig. S2). However, our data suggest that in many cases, these subspecies units and peripheral populations of globally secure species are being given high priority, while endemic and globally endangered species are neglected. It is clear from the low overall proportions of all taxonomic units with Action Plans that time and financial resources must be severely limited for management of species threatened with extinction in Canada. Given this, and that the burden of ensuring globally threatened species found in Canada do not go extinct is enshrined within Canadian Law, it is essential that such species be prioritized (SARA, 2002). For example, the red mulberry (*Morus rubra*) is currently listed as endangered in Canada, and has an Action Plan prepared, despite the fact that the plant is common in the United States, with a range spanning most of the eastern states and extending as far south as Florida (SARA, 2017). In contrast, the Okanagan efferia (*Efferia okanagana*), a Canadian endemic species, has no Action Plan prepared to facilitate its recovery. The red mulberry and the Okanagan efferia have similar listed threats (invasive species, habitat loss and degradation) and were listed at roughly the same time (2014 and 2011, respectively), suggesting that this discrepancy may represent a taxonomic bias, or political will (Martín-López et al., 2009). Our results also indicate that greater proportions of amphibians, reptiles, mammals and fish are being managed as subspecies units vs. the other taxa. This disparity could be due to several reasons, including the following: 1) these taxonomic groups tend to have larger ranges or greater distinctiveness among populations than other groups; 2) these groups receive more research and conservation attention than other groups, leading to greater recognition of distinct populations; or 3) protection of full species is often economically or politically unfeasible for some species in these groups. Greater population differentiation of dispersive organisms such as mammals, birds, amphibians and plants with seed-dispersal adaptations has been noted as a contributing factor to a greater number of DUs for these groups (Green, 2005). There is also considerable evidence for bias towards conservation of mammals and birds (Redding and Mooers, 2006; Findlay et al., 2009; Martín-López et al., 2009; Evans et al., 2016), and suggestion that this bias leads to greater research attention (Martín-López et al., 2009; Donaldson et al., 2016), possibly leading to greater recognition of distinct populations. The fact that mammals and birds had a higher proportion of Action Plans relative to their proportion of total listings (Fig. 2), as well as previous research (Mooers et al., 2007, 2010; Findlay et al., 2009; McCune et al., 2013; Favaro et al., 2014; McDevitt-Irwin et al., 2015), suggest that biases occur in listing and management of Canadian species at risk. In addition, Findlay et al. (2009) found that full species were less likely to be listed if they had commercial or subsistence harvesting as an explicitly identified threat, had the federal Department of Fisheries and Oceans as a responsible authority, were generally located in Canada's North (especially in Nunavut), or were found mostly or entirely within Canada. For example, listing only one population of a fish species opposed to the entire species would allow continued commercial harvesting in parts of its range.

We note that our study is limited to national-level Canadian species at risk programs, and that some species that are not protected federally may receive provincial protection (or vice-versa). Our analysis is also focused on species-level programs, rather than landscape-focused or even international habitat conservation programs that may be necessary to conserve many species. Nonetheless, many of the multi-species Action Plans we analyzed contain management prescriptions at the landscape scale, including actions designed to benefit multiple species. For example, the Action Plan for blue, fin, sei and North Pacific right whales (*Balaenoptera musculus, B. physalus, B. borealis and Eubalanea japonica*) encompasses the entirety of populations found within Canadian Pacific waters (DFO, 2011). Indeed, the majority of Action Plans analyzed are for multiple species (Table S4). Although we found similar results when looking at single species Action Plans separately (Table S3), the proportion of globally at risk species with single species Action Plans was marginally higher compared to full species that are not globally at risk.

In addition, we note that our analysis is based on ranking systems already in place (i.e., SARA and IUCN) and any bias in the listing process within these systems would also be reflected in our analysis of subsequent management. As theses biases have been previously documented (e.g., Mace et al., 2008; Findlay et al., 2009) it suggests that our analysis may underestimate the number of globally-threatened species in Canada that remain unprotected.

5. Conclusions

With the limited resources available to threatened species conservation programs, managers face the dilemma of prioritizing some species or populations over others. While there are many sound reasons for conserving subspecies units, given that resource allocation to threatened species programs appears to be severely limited in Canada (Environment Canada, 2012) and in general (e.g., Bottril et al., 2008; McCarthy et al., 2012), conservation programs globally must find more resources or undertake a sober evaluation of priorities. This evaluation includes deciding whether endemic and globally threatened species should be prioritized over peripheral populations of secure species. Canada offers an important perspective on this issue, due to its geographic location, as many populations may be threatened in Canada but globally secure. However, we suspect that analogous issues may exist in other jurisdictions. For example, in the USA, hundreds of threatened species remain seriously underfunded, many of which are endemics and many of which have modest funding requirements of < $100,000 USD (Gerber, 2016). Meanwhile, threatened populations of the Chinook salmon (*Oncorhynchus tshawytscha*), a species that is globally secure, received a total > $197 million USD per year from 1998 to 2012 (Evans et al., 2016). Obviously, financial requirements for recovery programs vary among species, and are important considerations in prioritization. However, we suggest that the full, endemic threatened species for which a jurisdiction bears the sole responsibility must be the highest priority, and that globally threatened species should also be given high priority.

Although SARA does not provide explicit guidance on prioritizing certain groups of species, this study as well as numerous others have confirmed that prioritization is occurring (e.g. Mooers et al., 2007, 2010; Findlay et al., 2009; Favaro et al., 2014; McDevitt-Irwin et al., 2015). Implementing regulations that more clearly delineate priority-setting processes, and that include endemicity as well as global risk status among priority assessment criteria for listing and management, should be considered as a potential mechanism to account for the apparently inadequate protection we found for many globally at risk species in Canada. We also recommend implementing a protocol to fast-track globally at risk and endemic species through listing to implementation of Action Plans, especially when such species are considered to be severely threatened. Placing priority on acting quickly is essential for these species, and a pathway must be provided to minimize the bureaucratic slowdowns that have contributed to the failure to prevent extinctions elsewhere (Martin et al., 2012).

Competing interest

The authors have no competing interests to declare.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.envsci.2018.03.001.

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