Contents lists available at ScienceDirect





Environmental Science & Policy

journal homepage: www.elsevier.com/locate/envsci

Critical habitat designation for Canadian listed species: Slow, biased, and incomplete



Sarah C. Bird, Karen E. Hodges*

Department of Biology, University of British Columbia Okanagan, 1177 Research Road, Kelowna, British Columbia, V1V 1V7, Canada

ARTICLE INFO

Article history: Received 13 October 2016 Received in revised form 20 January 2017 Accepted 24 January 2017 Available online xxx

Keywords: Critical habitat Canada Species at Risk Act Threats Endangered species Recovery strategies

ABSTRACT

Although endangered species legislation can be a powerful tool for protecting species, such laws are only as good as their implementation. Under the Canadian Species at Risk Act, Critical Habitat is designated in a Recovery Strategy as the habitat required for the recovery or survival of a listed species. We examined the finalized Recovery Strategies for 234 species and we found poor implementation of Critical Habitat designation for Canadian species. Most listed species (62.9%) lack Critical Habitat; only 11.8% have full Critical Habitat. Many species with Critical habitat obtained it years later than the statutory requirements. Designation is biased taxonomically, by major habitat type, and by lead agency. These results echo findings from the US Endangered Species Act, despite differences between the laws in when designation is supposed to occur. Additional funding and expertise would likely help reduce these delays. We also strongly encourage designation even in the face of incomplete information because of the significant negative consequences that can result from failure to protect the habitat of species at risk of extinction.

© 2017 Elsevier Ltd. All rights reserved.

1. Introduction

Endangered species legislation is necessary to protect species that are at risk of extirpation or extinction, as such laws aim to control human activities that lead to species declines. As of 2010, 36 countries had legislation to protect species at risk, including Australia, the United States, and Canada (Mooers et al., 2010). For the United States' 1973 Endangered Species Act (ESA), the oldest such law, a species' recovery is positively correlated with the time since being listed, having a Recovery Strategy, and designation of Critical Habitat (Taylor et al., 2005). Spending levels for protective actions may also be correlated with species recovery (Camaclang et al., 2015). The 2002 Canadian Species at Risk Act (SARA; partly implemented 2003, fully implemented 2004) is still quite young for assessing factors affecting recovery (McCune et al., 2013; Taylor and Pinkus, 2013), but intermediate analyses can address the activities and timing of post-listing implementation.

The Canadian Species at Risk Act has 5 stages: assessment, protection, recovery planning, implementation, and monitoring and evaluation (see also Mooers et al., 2010). Assessment is done by the non-governmental Committee on the Status of Endangered

Wildlife in Canada (COSEWIC), a body of experts that provides a scientific determination of the appropriate risk category for each species; the Minister of Environment then decides whether to accept COSEWIC's recommendation to list the species under SARA. Once a species is listed on Schedule 1 of the Act, the law automatically protects it from physical harm, capture, and trading. In the recovery planning stage, Recovery Strategies, Management Plans, and Action Plans are prepared by the appropriate organizations, i.e. Parks Canada Agency (PC; species occurring in Parks), Environment Canada (EC; migratory birds and terrestrial species), and the Department of Fisheries and Oceans Canada (DFO; aquatic species). In some cases, two agencies work together on species protection when species occur in both mandates. The competent ministers are responsible for ensuring Recovery Strategies are written, but Recovery teams include experts from academia, NGOs, industry, and government.

The goals of SARA are to protect species from extirpation and extinction, enable recovery for species at risk from anthropogenic causes, and prevent species listed under the Act from deteriorating to a higher risk status (SARA, SC 2002, c 29). These goals are addressed through listing species, developing Recovery Strategies with Critical Habitat for Endangered, Threatened, or Extirpated species (or Management Plan for species of Special Concern), and developing Action Plans to implement the Recovery Strategies. SARA allows subspecific protection for "Designatable Units" (DUs)

^{*} Corresponding author.

E-mail addresses: sarahcbird@gmail.com (S.C. Bird), karen.hodges@ubc.ca (K.E. Hodges).

that are independently assessed for listing status and recovery. DUs can arise, for example, when the species occurs in disjunct populations or there is clear genetic subdivision. For species for which recovery is deemed not feasible, a Recovery Strategy is prepared describing why recovery is not feasible (SARA 41(2)), and how the survival of the species will be ensured (Government of Canada, 2016).

The law specifies that the Recovery Strategy should identify Critical Habitat. Under SARA. Critical Habitat is defined as habitat "necessary to the survival or recovery" of species at risk (SARA, SC 2002, c 29); it recognizes that many species face habitat-related threats and will need habitat protection to avoid extirpation. "Partial" Critical Habitat is not defined in SARA, but many Recovery Strategies only identify "partial" Critical Habitat, which is recognized within the Recovery Strategy as inadequate for species recovery (even if all known and available habitat is designated) or needing additional study before full Critical Habitat designation is possible. In cases of partial Critical Habitat designation, the Recovery Strategies must include a Schedule of Studies describing research that will allow full Critical Habitat designation to occur, and providing a non-binding timeline for such research. Critical Habitat protection under SARA is only applicable on Federal Land, or by ministerial order for all other lands.

The statutory timelines specify that there should be a proposed Recovery Strategy for each Endangered species within one year of listing (two years for Threatened/Extirpated species), followed by 60 days for comments and 30 days for finalizing the Plan (SARA 2002, sec 42(1)). The species listed at the time the law came into force were granted extensions for the draft Recovery Strategies. These timelines differ from the American ESA, which requires the designation of Critical Habitat when a species is listed; many ESA-listed species still lack Critical Habitat, others have had significantly delayed designations, and many listings have been delayed as well (Hagen and Hodges, 2006; Schwartz, 2008).

Early analyses of SARA suggest the required post-listing steps are not being implemented effectively (Environment Canada, 2012; Taylor and Pinkus, 2013). In the first years of the law, Critical Habitat was not adequately identified and Action Plans and Management Strategies were seldom prepared within legislated timelines (Environment Canada, 2012). For example, Mooers et al. (2010) found that only 23% of listed species (including those of Special Concern) had Critical Habitat designated (however they do not distinguish between full and partial Critical Habitat designation). For a subset of Canadian species that have been reassessed by COSEWIC, Favaro et al. (2014) found that more than 50% of SARAlisted species lacked full Critical Habitat designation. Camaclang et al. (2015) compare implementation of Critical Habitat provisions for subsets of Australian, American, and Canadian species, with a focus on the kinds of information used in making designations. These analyses all point to implementation delays and concerns over limited Critical Habitat designation.

Indeed, two early lawsuits successfully challenged agency failure to designate Critical Habitat for Nooksack Dace (*Rhinichthys cataractae*), and Greater Sage Grouse (*Centrocercus urophasianus urophasianus*) (Alberta Wilderness Association v. Minister of the Environment, 2009 FC 710; Environmental Defense Canada v. Minister of Fisheries and Oceans, 2009 FC 878). For these species, the competent ministers used "ministerial discretion" to omit Critical Habitat from the Recovery Strategies, but the courts found these decisions were unlawful and that the ministers did not have such discretion; the decisions affirmed that SARA's statutory requirements had not been met. Similarly, a case about orcas (*Orcinus orca*; Georgia Strait Alliance v. Minister of Fisheries and Oceans, 2010 FC 1233) addressed delays in Critical Habitat designation, finding among other decisions that DFO could not avoid Critical Habitat designation under SARA by claiming habitats were already protected under other laws or conservation agreements.

After these 2009–2010 litigation decisions, the proportion of listed species with proposed Recovery Strategies that contained Critical Habitat increased by over 50%, suggesting that implementation of Critical Habitat can be improved (Taylor and Pinkus, 2013). Although this trend is promising, we note the salient issue is the finalized Recovery Strategies, as proposed Strategies do not force legal protection and there are numerous cases where the required timelines between proposed and final Strategies have not been met. Unfortunately, timeline problems have persisted: Western Canada Wilderness Committee v. Minister of Fisheries and Oceans (2014 FC 148) is a more recent case challenging delays beyond statutory timelines in formation of Recovery Strategies for 4 species, although the case also notes statutory violation of timelines for 167 species at that time. The court upheld the suit by finding that the ministers' failure to meet statutory timelines was unlawful.

Another problem with SARA implementation is that biases occur in the identification of Critical Habitat. Favaro et al. (2014) found that reptiles, birds and marine fish had a lower rate of Critical Habitat designation than did other taxa. Additionally, the Department of Fisheries and Oceans produced a significantly lower proportion of Recovery Strategies containing Critical Habitat than the other two responsible agencies, Environment Canada and Parks Canada (Taylor and Pinkus, 2013). It is unclear if these weak implementation trends and biases have continued or if recent actions have been more timely and complete, as authors of Recovery Strategies gain experience with the law and as the case law has so far found that these timelines are non-discretionary.

Here we review the designation of Critical Habitat for all species with finalized Recovery Strategies as of August 2015. Our analysis extends previous reviews by several years of implementation, increases the number of species examined, examines all rather than just some of the finalized Strategies, and separates partial and full Critical Habitat designations. We examine biological and agency factors in relation to timing of designation and how many species have not had Critical Habitat designated or have only partial designations. We also examine the major threats identified in Recovery Strategies. We find habitat threats are pervasive but that critical habitat implementation is still poor, leaving many species with delayed or no habitat protection.

2. Methods

We examined Critical Habitat designations for all SARA-listed species that had finalized Recovery Strategies as of August 2015. Because some species are separated into subspecifc "Designatable Units" (DUs) our analysis hereafter is based on DUs (we use both terms hereafter, as the majority of cases are species). Environment Canada provided a dataset of the exact dates of SARA listing for each DU. We omitted 3 cases for species that have Recovery Strategies but are currently listed as Special Concern and hence are not legally required to have Recovery Strategies. Our analysis includes 234 DUs (223 species) from 200 Recovery Strategies.

We used the SARA public registry (Government of Canada, 2015) for DU data from Species Profiles and Recovery Strategies; Critical Habitat data were collected from finalized Recovery Strategies. We used data only from finalized Recovery Strategies because proposed Recovery Strategies do not offer legal protection for species and in some cases proposed and final strategies were quite different. For all assessed DUs, we collected data on species biology, administrative information, threat types, and type of Critical Habitat designated (Appendix A). Administrative information included data on the lead agency for the Recovery Strategy, current SARA status, and number of provincial jurisdictions

spanned by the DU. Recovery Strategies identified threats to the species, sometimes in generic terms (e.g. "habitat loss"), but in some cases with enough specificity that we could assign threats to the corresponding first-level IUCN threat categories for analysis (McCune et al., 2013; Prugh et al., 2010). Data describing Critical Habitat included status (Full, Partial, or Absent; see also Favaro et al., 2014), and dates for species listing, finalization of Recovery Strategy, and Critical Habitat designation.

Previous studies and lawsuits have signalled implementation issues including taxonomic biases, agency differences in implementation rates, and significant delays in implementation. We explored all of these issues with data for finalized Recovery Strategies only. We also asked if Endangered species had better implementation rates than Threatened species, given that Endangered species are by definition considered to be in more need of protection. We briefly examined the species' dominant habitat type to see if differences in critical habitat designation were at all explained by whether species were riparian, terrestrial, freshwater, or marine. We examined if endemics or species with a high proportion of their global range within Canada were more likely to receive timely and full Critical Habitat than were species with only a small fraction of their range in Canada. We wondered if species that spanned multiple jurisdictions would have worse delays or be more likely to have no critical habitat due to the additional complexity of working across jurisdictions. We also compared Critical Habitat designation (Full, Partial, None) against the threats identified in finalized Recovery Strategies.

3. Results

As of August 2015, 391 Designatable Units had been listed under SARA as Threatened, Endangered, or Extirpated, i.e. the classifications that trigger the statutory requirements for Recovery Strategies and Critical Habitat. Of these listed DUs, 234 (59.8%) have Recovery Strategies (Table 1). Out of the 391 listed species only 46 DUs (11.8%) have full Critical Habitat designated in a finalized Recovery Strategy and an additional 99 (25.3%) have partial Critical Habitat designated. That leaves 246 DUs (62.9%) with no designated Critical Habitat.

There are clear taxonomic biases in Critical Habitat designation (Table 1). Plants and mosses are the most likely to have full Critical Habitat (20.7% and 18.7% respectively), while no reptiles, molluscs, marine mammals, or marine fish have full Critical Habitat. When considering taxa with full or partial Critical Habitat, these

differences continue (lumping mosses/lichens and marine/freshwater fish we tested DUs with or without Critical Habitat designated: χ^2 = 26.8, p = 0.001). Nearly half of mosses, lichens, and vascular plants have either full or partial Critical Habitat, whereas <25% of arthropods, molluscs, reptiles, and amphibians have any designated Critical Habitat.

Species listed as Threatened and Endangered have Critical Habitat designated at similar rates (Table 2). Although a higher percentage of Threatened DUs have some form of Critical Habitat (Threatened: 72.8%, Endangered: 61.8%), this difference is not statistically significant (χ^2 = 2.13, p = 0.14). For 13 Extirpated DUs, recovery is deemed not feasible and Critical Habitat has not been designated; two others have plans for reintroductions.

The Critical Habitat protections also vary with the primary habitat of the species (Table 2; comparing none vs any Critical Habitat ($\chi^2 = 10.4$, p = 0.016). Marine species (including sea birds and anadromous fish) have particularly low rates of designation, with no DUs having full Critical Habitat and only 40.7% (11 of 27) having partial Critical Habitat. Freshwater species are also poorly protected, with only 9.3% having full Critical Habitat. Species using terrestrial or riparian habitats are more likely to have full Critical Habitat, at 21.2% and 38.9% respectively.

For species with Recovery Strategies, 169 of 234 Strategies indicated how much of the species' global range occurs within Canada. Among these cases, 39 listed DUs are endemic to Canada; of these endemics 6 have full Critical Habitat, 16 have partial

Table 2

Number of Designated Units with Full, Partial, or Absent Critical Habitat based on listing status and primary habitat type. Marine species include sea birds and anadromous fish.

	Absent (89)		Full (46)		Partial (99)	
	n	%	n	%	n	%
SARA Status						
Threatened (70)	19	27.1	16	22.9	35	50.0
Endangered (149)	57	38.3	30	20.1	62	41.6
Extirpated (15)	13	86.7	0	0	2	13.3
Primary habitat type						
Riparian (36)	10	27.8	14	38.9	12	33.3
Terrestrial (128)	42	32.8	28	21.9	58	45.3
Freshwater (43)	21	48.8	4	9.3	18	41.9
Marine (27)	16	59.2	0	0	11	40.7

Table 1

Taxa listed under the Canadian Species at Risk Act that have Critical Habitat designated as of August 2015. Because these DUs are listed as Threatened (T), Endangered (EN), or Extirpated (EX), by law they should have a Recovery Strategy and Critical Habitat designated (species listed as Special Concern or holding other statuses do not require these protections). Percentages are out of the number of DUs in each taxon. The table is ordered by the percentage of each taxon with full Critical Habitat. Three species were listed as Endangered in November 2014, so had not yet exceeded the statutory timelines at the time of our analysis.

	Listing	g status		Recovery Strategy full Critical Habitat		partial Critical Habitat		any Critical Habitat		
Taxon (n)	Т	EN	EX	n	%	n	%	n	%	%
Vascular plant (145)	48	94	3	97	66.9	30	20.7	40	27.6	48.3
Mosses (11)	3	7	1	8	72.7	2	18.2	3	27.3	45.5
Lichen (6)	2	4	0	4	66.7	1	16.7	2	33.3	50.0
Bird (52)	22	28	2	30	57.7	6	11.5	14	26.9	38.5
Freshwater fish (38)	11	24	3	29	76.3	3	7.9	12	31.6	39.5
Amphibian (14)	5	8	1	3	21.4	1	7.1	0	0	7.1
Arthropod (32)	6	23	3	13	40.6	2	6.3	5	15.6	21.9
Terrestrial mammal (23)	8	13	2	11	47.8	1	4.4	7	30.4	34.8
Reptile (31)	12	15	4	8	25.8	0	0	5	16.1	16.1
Mollusc (19)	2	15	2	12	63.2	0	0	3	15.8	15.8
Marine mammal (15)	6	7	2	14	93.3	0	0	6	40	40
Marine fish (5)	2	3	0	5	100	0	0	2	40	40
Total (391)	127	241	23	234	59.8	46	11.8	99	25.3	37.1

Critical Habitat, and the remaining 17 do not have Critical Habitat. Endemic DUs that lack Critical Habitat are mostly Endangered freshwater species. A further 113 DUs have less than 25% of their global range in Canada, and of these 18 and 53 have full or partial Critical Habitat, respectively. For the 17 DUs with 25–99% of the species' global range within Canada, 4 have partial and 8 have full Critical habitat. The amount of a species' range within Canada (endemic, <25%, 25–99%) did not affect whether the species had any Critical Habitat designated within the Recovery Strategy (χ^2 = 1.08, p = 0.58).

For listed DUs with Recovery Strategies, most (182 of 234) fall under only one provincial/territorial jurisdiction. For species with ranges in fewer than 3 jurisdictions, 19.8% of species have full Critical Habitat and 41.4% have partial Critical Habitat. Six species have ranges spanning more than 3 jurisdictions; Environment Canada is the lead agency for all of them, and 4 have partial and 1 has full Critical Habitat. We detected no statistical difference in designation rate for species with ranges in 1 vs. more than 1 jurisdiction (χ^2 = 2.6, p = 0.11). Lead agency did affect designation rates (Fig. 1; χ^2 = 17.3, p < 0.001): Environment Canada is the lead agency for most Recovery Strategies (110 of 234) and has designated some form of Critical Habitat for 74.5% of these species. The Department of Fisheries and Oceans has the lowest rate of Critical habitat designation (42.3%), despite having the lowest number of DUs (59) under their jurisdiction.

The first Recovery Strategies and Critical Habitat designations were published in 2006, 2 years after SARA was fully implemented. The statutory requirement calls for Endangered Species to obtain Recovery Strategies within 1 year and Threatened species within 2 years. The median time between listing under SARA and publication of a Recovery Strategy was 4.8 years (quartiles 3.3–7.7), and the median time between listing and Critical Habitat designation was 7.1 years (quartiles 4.4–8.8). For Endangered species, the time from listing to Recovery Strategy was 1.4 years earlier than for Threatened species (5.2 years for Endangered vs. 6.6 years Threatened). Similarly, the median time between listing and Critical Habitat designation for Endangered species was 1.6 years earlier than the time for Threatened species (6.2 years vs 7.8 years).

Delays in Recovery Strategies and Critical habitat designation beyond statutory requirements are common and on-going. Many



Fig. 1. Type of Critical Habitat designation for Recovery Strategies posted by each lead agency: Department of Fisheries and Oceans (DFO), Environment Canada (EC), and Parks Canada Agency (PC).

species with older Recovery Strategies do not have designated Critical Habitat within those Strategies (Fig. 2), but more recent Recovery Strategies are somewhat more likely to have either full or partial Critical Habitat. A few recently listed species are getting Critical Habitat more swiftly than the species listed early in the law's implementation (Table 3). We compared DUs listed in 2005–2008 to 2009–2012 that obtained Recovery Strategies within 3 years (generously longer than the statutory requirements of 1 year for Endangered and 2 years for Threatened); they had similar proportions (12.5 vs 10.6%, χ^2 = 0.07, p = 0.80), but more DUs had Critical Habitat designations within 3 years of listing in the later period (1.5% early vs. 8.2% late, χ^2 = 6.13, p = 0.013).

Recovery Strategies did not consistently use IUCN threat categories by name. We did note "habitat loss", "habitat degradation", or "habitat fragmentation" were mentioned as general issues for 97% of DUs. For specific threats we could refer to IUCN categories, invasive and other problematic organisms, natural systems modifications, and human intrusions and disturbance were the most common (Table 4).

4. Discussion

Critical Habitat designation under the Canadian Species at Risk Act is not meeting statutory requirements. As of August 2015, a small 11.8% of listed Designatable Units had Critical Habitat fully designated, while 62.9% had no Critical Habitat designation whatsoever. Designations are proceeding slowly, with the majority occurring several years after the statutory timelines. There are also clear biases in designation with taxon, the habitat type the organism occupies, and lead agency. Almost all Recovery Strategies identify habitat-related threats to species, as is also true for listed species (McCune et al., 2013; Prugh et al., 2010), so the failure to designate Critical Habitat is troubling as these dominant threats are not being addressed via protecting habitats. Collectively, these patterns signal that the Critical Habitat provisions of the law are suffering from serious implementation problems. Because many listed species lack Recovery Strategies, delays in Critical Habitat designation often stem from trouble meeting that statutory requirement.

Within the Recovery Strategies, most delays or omissions of Critical Habitat are blamed on insufficient knowledge. Specifically, the high majority (157 of 188 cases, 83.5%) of Recovery Strategies that did not identify Critical Habitat, or that identified partial Critical Habitat, justified these decisions by stating that more research was needed, specifying lack of knowledge on species biology, distribution, abundance, habitat availability, habitat use, or lack of concrete recovery goals. Minority reasons for the failure to designate full Critical Habitat were that the recovery was deemed not feasible (n=7), or because a historically recorded population needed to be verified first (n=12); another 12 provided unique reasons that could not be lumped into a cohesive category.

As examples, Butternut trees (*Juglans cinerea*) are severely threatened by the Butternut Canker (*Ophiognomonia clavigignentijuglandacearum*), a non-habitat-related threat, so no Critical Habitat was designated, although the authors of the 2010 Recovery Strategy were willing to reconsider if later work showed trees had increased disease-resistance in particular habitats. In another case, a multi-species Recovery Strategy (2006) for five woodland plant species in the Garry Oak (*Quercus garryana*) ecosystem states that "much is known about the habitat needs" for the species, then provides specific information about occupied and potential habitat, yet the authors stated more detailed research was required prior to designating Critical Habitat. This Recovery Strategy anticipated Critical Habitat designation would occur prior to 2010, but it was not until 2016 that partial Critical Habitat was designated for the relevant species. This type of assessment



Fig. 2. Number of finalized Recovery Strategies posted each year that received Critical Habitat designations by August 2015. Most Recovery Strategies designated Critical Habitat the year they were posted, but for 7 cases, the Critical Habitat was designated between 9 months and 7 years 3 months after the initial Recovery Strategy was posted.

Table 3

Recovery Strategies and full or partial Critical Habitat in relation to year of listing. Values count whether DUs had received Recovery Strategies and Critical Habitat within 3 years (hence this table ends with listing year 2012); this cut-off is longer than the 1–2 year statutory requirements, but the majority of listed species do not meet our generous timeline.

Year	DUs listed each year	Recovery Strategy within 3 years		Critical Habitat within 3 years		Critical Habitat later than 3 years	
		n	%	n	%	n	%
2005	120	24	20.0	3	2.5	26	21.6
2006	44	1	2.3	0	0	18	40.9
2007	36	0	0	0	0	11	30.6
2008	0	-	-	-	-	-	-
2009	22	0	0	0	0	3	13.6
2010	22	2	9.1	1	4.5	4	18.2
2011	23	6	26.1	5	21.7	1	4.3
2012	18	1	5.6	1	5.6	0	0

Table 4

Threat types for DUs with no, full, or partial Critical Habitat. Values are counts, with the numbers in parentheses representing the percent of total DUs (N = 234) affected by each threat type. No Recovery Strategies identified "Geological Events" as a threat. Most DUs were affected by multiple threats, so the total number of "DUs with threat" is much higher than the 234 DUs with Recovery Strategies.

Threat	DUs with threat n (%)	Absent	Full	Partial
IUCN Threat Category				
Invasive species, genes, and diseases	149 (63.6)	52	32	65
Pollution	117 (50.0)	52	17	48
Human intrusions and disturbances	114 (48.7)	35	28	51
Natural systems modification	102 (43.6)	36	31	35
Biological resource use	84 (35.9)	35	12	37
Agriculture and aquaculture	71 (30.3)	30	9	32
Climate change and severe weather	71 (30.3)	17	16	38
Residential and commercial development	71 (30.3)	19	18	34
Other options	69 (29.5)	26	16	27
Energy production and mining	48 (20.5)	15	11	22
Transportation and service corridors	21 (9.0)	11	2	8

occurred numerous times in Recovery Strategies. The 2010 Recovery Strategy for Least Bittern (*lxobrychus exilis*) exemplifies a partial critical habitat case, as only breeding habitat was deemed to have enough spatial and biological information for designating Critical Habitat. The authors cite a lack of knowledge about habitat use for other activities such as migration, foraging and molting to be able to designate Critical Habitat for those activities. This type of statement was common among DUs that used different habitats at different times of year or for different behaviours.

Even if knowledge of the species' life history and habitat requirements is incomplete, these long durations between listing, Recovery Strategies, and Critical Habitat designation are concerning. For species at risk of extinction, delays in habitat protection are especially problematic because almost all listed species are threatened by habitat loss, fragmentation, or degradation. The anthropogenic causes for these habitat threats can rapidly increase in severity and can be irreversible (Prugh et al., 2010), meaning delays in habitat protection can damage imperilled species. Martin et al. (2016) also point to the significant damage to species that can be done by delaying designation in the quest for improved data on which to base a designation.

Our finding that there are taxonomic biases in designation of Critical Habitat aligns with previous reviews of SARA that found biases in listing and Recovery Strategies (McCune et al., 2013; Mooers et al., 2007), as well as Critical Habitat (Favaro et al., 2014). For example, for species identified by COSEWIC as imperilled, plants and herpetofauna are more likely to be listed under SARA than are terrestrial mammals and marine fish (Mooers et al., 2007). Once listed, plants are more likely to receive a Recovery Strategy and have Critical Habitat designation. This consistency in taxonomic bias throughout different stages of the law's implementation suggests that it is easier to identify and manage risks for sessile terrestrial organisms than for mobile or aquatic species.

Although Endangered species are, by definition, more at risk of extinction than Threatened species, a higher percentage of Threatened species than Endangered species have Critical Habitat. Endangered taxa did receive earlier Recovery Strategies and designation of Critical Habitat, reflecting the shorter statutory timeline for Endangered species. We are not sure what has led to Threatened species out-pacing Endangered species in the over-all percentage with Critical Habitat, but clearly more effort should be placed on designating Critical Habitat swiftly for all Endangered species.

We are also concerned to note that Critical Habitat designation is rare for aquatic species and for species endemic to Canada. These biases may be related, as most of the endemic DUs without Critical Habitat are freshwater species under the remit of the Department of Fisheries and Oceans, which is the agency least likely to develop Recovery Strategies or designate Critical Habitat. Additionally, endemic DUs were just as likely to receive Critical Habitat as DUs with 1–24% or 25–99% of their global range in Canada; we recommend that endemics are prioritized in the case of limited funding. Obviously, if Canada fails to protect its endemic species, these species would be lost globally; we hope that in the near future Canada's imperiled endemics are given the full legal protection that SARA requires.

As of August 2015, only 37.1% of Canadian listed species had either full or partial Critical Habitat designated. This result occurs both because of the slow development of Recovery Strategies (40.2% of species lack Recovery Strategies) and because 38% of DUs with Recovery Strategies did not have Critical Habitat designated within those Recovery Strategies. These numbers are poor compared to species listed under the US Endangered Species Act. In the US (as of June 2016), 72.6% of the 1596 US-listed species had Recovery Plans; 46.5% of the US-listed species had final Critical Habitat designation (www.fws.gov/endangered). The ESA implementation has been sharply criticized for its poor record on Recovery Planning (Doak et al., 2015; Gerber, 2016) and Critical Habitat designation (Camaclang et al., 2014, Hagen and Hodges, 2008; Robbins, 2010), so it is discouraging to see that the first decade of SARA's implementation has yielded such a poor record. There was some hope that SARA's moving Critical Habitat from the listing process to recovery planning would aid with Critical Habitat designation by allowing listing to be rapid, and to give more time to analyze recovery needs and Critical Habitat (Mooers et al., 2010; Waples et al., 2013). So far, these suggested benefits do not seem to have manifested.

4.1. Possible causes for implementation problems

Determining the reasons for delayed Recovery Planning and delayed Critical Habitat would require a separate study and is beyond our scope. In casual conversation, we have heard several common themes from government biologists and members of COSEWIC that also accord with the published literature on conservation law and policy. Specifically: 1) endangered species laws are often severely underfunded; 2) there are capacity issues in terms of staffing and relevant expertise; 3) required consultations often suffer from slow responses from the people whose expertise is solicited (which may again reflect capacity issues), and 4) ignorance about salient species biology is often a barrier for decision-makers. Further, the disparity in Critical Habitat designation across agencies may arise from different historic mandates, while limits in funding and expertise are obvious barriers to full and timely implementation of the law (Taylor and Pinkus, 2013). Lawsuits also affect agency implementation timing and practice (Taylor and Pinkus, 2013), as has also been noted for US Critical Habitat designation (Hodges and Elder, 2008).

The Canadian case law also indicates that such delays in Recovery Strategies and Critical Habitat designation, some of them "egregious", "resulted from conscious decisions within the Ministers' departments" (Western Canada Wilderness Committee v. Minister of Fisheries and Oceans 2014 FC 148); further, they represent "an enormous systemic problem within the relevant ministries". In their defence, in this court case DFO and Environment Canada noted four major challenges to timely implementation of the law, namely (1) developing policy and recruiting people with appropriate expertise in the early years after SARA's passage; (2) staff capacity both scientifically and for the required consultations; (3) the challenge of moving from scientific data to Critical Habitat designation; and (4) adjusting their implementing policy in reaction to previous case law. Again, it is beyond our purpose in this paper to examine causes of delays in depth, but we see no reason to doubt that these are genuine problems; it is unclear if they include all of the barriers to implementation.

A comprehensive analysis of the reasons behind delays in Recovery Planning and Critical Habitat designation might lead to clear targets for reform and better outcomes for species, although we note that "analysis paralysis" might stem from a backwardlooking focus on reasons for poor performance rather than a forward-looking emphasis on specific changes in practice that could be tried. It is not always necessary to know causes to be able to make significant improvements in practice: a doctor does not need to know the cause of a broken arm bone (fall, fight, slip, or other cause) to be able to set the bone for successful healing. For SARA, both case law and previous papers have already identified a number of possible causes of this broken implementation record, so we would prefer to see the research and policy analyses shift to a thoughtful and fast look at concrete actions that could change during implementation. In particular, we would welcome an experiment consisting of the government providing much more substantial funding for post-listing implementation (thus buying people's time and expertise); we think it would be insightful to see how Recovery Strategies and Critical Habitat designations occur in a well-funded setting. We predict that a small handful of residual problems might remain, stemming from particularly thorny ecological or economic problems, but that for many cases a simple increase in capacity would be effective. We would also welcome efforts to develop strong criteria or decision trees for translating biological data into policy decisions (Hagen and Hodges 2006; Hodges and Elder 2008; Martin et al., 2016), and adequate funding for conducting the Schedule of Studies that are identified in so many of the Recovery Strategies that lack Critical Habitat or designated it only partially.

5. Conclusion

The Canadian Species At Risk Act has a critical goal to prevent the loss of imperiled species from Canada. Its mandated Recovery Strategies and Critical Habitat designation for listed species reflect strong conservation science: habitat loss is a primary cause of species loss, so protecting Critical Habitat is indeed a vital step towards preventing extinction. Unfortunately, current implementation of the law is sorely lagging the law's intent; the majority of species are not being afforded the protections the law is required to offer to them.

Capacity issues in expertise and funding reflect the social and economic context in which endangered species work is conducted; these problems will need political and social solutions. The issue of knowledge requirements for Critical Habitat designation has been analyzed in papers about decision-making theory, the precautionary principle, and the use of criteria while making decisions (e.g. Martin et al., 2016), but we have yet to see systematic uptake of such approaches in the responsible ministries. Several of the court case decisions also explicitly recognized that Recovery Strategies and Critical Habitat designation under SARA were intended to be precautionary in nature (e.g. Alberta Wilderness Association v. Minister of the Environment, 2009 FC 710). We strongly urge that the people involved in writing and approving Recovery Strategies move away from using ignorance of species requirements as an excuse for not designating Critical Habitat. Instead we advocate using decision-making frameworks to proceed despite knowledge gaps, thus echoing what SARA itself mandates. We see this cultural shift in agency practice as essential if we are to prevent extinctions. The present implementation seriously under-protects species, and shifting to precautionary and rapid protection of habitat is likely to be more effective at conservation than is the current failure to follow the law.

Indeed, in the words of Justice Mactavish (2014; ¶71, Western Canada Wilderness Committee v. Minister of Fisheries and Oceans 2014 FC 148) "I agree with the applicants that 'the perfect should not become the enemy of the good' . . . Section 38 of SARA (which incorporates the "precautionary principle" into the Act) is very clear: the preparation of a recovery strategy for a species at risk "should not be postponed for a lack of full scientific certainty."" We also agree.

Acknowledgements

We thank Environment Canada for the database of exact listing dates. This work was supported by the Natural Sciences and Engineering Research Council [Discovery Grant number 31222 and a USRA fellowship]. The funder had no involvement in the research. The authors declare no conflict of interest.

Appendix A.

See Table A1.

Table A1

Data analysed in this paper from finalized Recovery Strategies accessed from the SARA public registry; we included all cases completed before August 2015.

Data type	Criteria, Categories
Species status	The SARA designations of threatened, endangered, or extirpated, as per the status indicated on the SARA public registry species profile
Date of species listing	These dates were obtained from Environment Canada.
Habitat type (FW=Fresh water, M=Marine, T=Terrestrial, R=riparian)	We recorded the type of habitat used by each DU. Marine (M), terrestrial (T), and Freshwater (FW) species/DUs use that type of habitat exclusively. A few species were M/T or M/FW as they used both habitat types at some point during their lives (seabirds, anadromous fish); we included these cases in our marine category. Riparian species included species that required freshwater habitat and adjacent terrestrial habitat (e.g. turtles, shorebirds) or lived in the water/land shorelines (e.g. some plants).
Taxon	We followed the groupings used by the SARA public registry.
Lead agency	We recorded which agency was the lead agency for the Recovery Strategy from the citation for each Recovery Strategy. For a few strategies, 2 agencies were clearly identified as co-leads, but in most cases with two agencies, one was clearly the lead.
Number and identity of jurisdictions in which DU occurs	We recorded provincial or territorial jurisdictions in which each DU occurs. These jurisdictions include 13 provinces and territories, along with Arctic Ocean, Atlantic Ocean, and Pacific Ocean.
Percentage of global range in Canada	Many Recovery Strategies gave the percentage of the DU's global range that is within Canada. We binned these data into three categories: 1–24%. 25–99%, and endemic (100%).
Date of Recovery Strategy	The date of the finalized Recovery Strategy for each DU was taken from the SARA public Registry. For any final Recovery Strategies that were amended after publication, the date of the non-amended recovery strategy was used, as that was the date the Recovery Strategy first had legal power.
Date of initial Critical Habitat designation	We recorded the earliest date Critical Habitat was identified legally for a species in a finalized Recovery Strategy, federal order, or a Recovery Strategy amendment. For species without Critical Habitat, no date was recorded.
Type of Critical Habitat designation (Full, partial, absent)	We recorded whether a species has no critical habitat ("absent"), Full Critical Habitat (the habitat defined as meets the recovery or survival needs of the species in question and no further Critical Habitat needs to be defined), or Partial Critical Habitat (current data are used to determine as much Critical Habitat as possible, but more is required to meet the recovery or survival needs of the species, and typically a schedule of studies to gather data needed to define the rest of the Critical Habitat is provided).
Reason for no or partial Critical Habitat Designation	Each Recovery Strategy provided some reasoning for why Critical Habitat was not designated. We used the written reasoning provided in the strategy, along with the schedule of studies, to identify major reasons for the lack of full designation.
Threats to population	We collated all identified or likely threats listed within Recovery Strategies. We then binned these threats based on the IUCN version 3.2 level 1 threat categories.

References

- Camaclang, A.E., Maron, M., Martin, T.G., Possingham, H.P., 2015. Current practices in the identification of critical habitat for threatened species. Conserv. Biol. 29, 482–492.
- Doak, D.F., Himes Boor, G.K., Bakker, V.J., Morris, W.F., Louthan, A., Morrison, S.A., Stanley, A., Crowder, L.B., 2015. Recommendations for improving recovery criteria under the US Endangered Species Act. Bioscience 65, 189–199.
- Environment Canada, 2012. Evaluation of Programs and Activities in Support of the Species at Risk Act. Audit and Evaluation Branch. 77 p.
- Favaro, B., Claar, D.C., Fox, C.H., Freshwater, C., Holden, J.J., Roberts, A., UVic Research Derby, 2014. Trends in extinction risk for imperilled species in Canada. PLoS One 9, e113118.
- Gerber, L.R., 2016. Conservation triage or injurious neglect in endangered species recovery. Proc. Natl. Acad. Sci. 113, 3563–3566.
- Government of Canada, 2015. Species At Risk Public Registry. https://www. registrelep-sararegistry.gc.ca/.
- Government of Canada, 2016. Policy on Survival and Recovery [Proposed]. Species at Risk Act: Policies and Guidelines Series. Government of Canada, Ottawa (8 pp.).
- Hagen, A.N., Hodges, K.E., 2006. Resolving critical habitat designation failures: reconciling law, policy, and biology. Conserv. Biol. 20, 399–407.
- Hodges, K.E., Elder, J., 2008. Critical habitat designation under the US Endangered Species Act: how are biological criteria used? Biol. Conserv. 141, 2662–2668.
- Martin, T.G., Camaclang, A.E., Possingham, H.P., Maguire, L.A., Chades, I., 2016. Timing of protection of critical habitat matters. Conserv. Lett. doi:http://dx.doi. org/10.1111/conl.12266.
- McCune, J.L., Harrower, W.L., Avery-Gomm, S., Brogan, J.M., Csergö, A.-M., Davidson, L.N.K., Garani, A., Halpin, L.R., Lipsen, L.P.J., Lee, C., Nelson, J.C., Prugh, L.R., Stinson, C.M., Whitney, C.K., Whitton, J., 2013. Threats to Canadian species at risk: an analysis of finalized recovery strategies. Biol. Conserv. 166, 254–265.
- Mooers, A.O., Prugh, L.R., Festa-Bianchet, M., Hutchings, J.A., 2007. Biases in legal listing under Canadian endangered species legislation. Conserv. Biol. 21, 572– 575.

- Mooers, A.O., Doak, D.F., Findlay, C.S., Green, D.M., Grouios, C., Manne, L.L., Rashvand, A., Rudd, M.A., Whitton, J., 2010. Science, policy, and species at risk in Canada. Bioscience 60, 843–849.
- Prugh, L.R., Sinclair, A.R.E., Hodges, K.E., Jacob, A.L., Wilcove, D.S., 2010. Reducing threats to species: threat reversibility and links to industry. Conserv. Lett. 3, 267–276.
- Robbins, K., 2010. Recovery of an endangered provision: untangling and reviving critical habitat under the Endangered Species Act. Buffalo Law Rev. 58, 1095– 1126.
- SARA (Species At Risk Act). 2002. c 29.
- Schwartz, M.W., 2008. The performance of the Endangered Species Act. Ann. Rev. Ecol. Evol. Syst. 39, 279–299.
- Taylor, E.B., Pinkus, S., 2013. The effects of lead agency, nongovernmental organizations, and recovery team membership on the identification of critical habitat for species at risk: insights from the Canadian experience. Environ. Rev. 21, 93–102.
- Taylor, M.F.J., Suckling, K.F., Rachlinski, J.J., 2005. The effectiveness of the endangered species act: a quantitative analysis. Bioscience 55, 360–367.
- Waples, R.S., Nammack, M., Cochrane, J.F., Hutchings, J.A., 2013. A tale of two acts: endangered species listing practices in Canada and the United States. Bioscience 63, 723–734.

Ms. **Sarah C. Bird** is a recent BSc. graduate planning to pursue Masters studies in Environmental Science and Sustainability. She has an interest in systems levels approaches to human-ecosystem conflicts. She hopes to conduct research investigating the balance between human interests and ecosystem conservation through the efficient development of human systems.

Dr. **Karen E. Hodges** is an associate professor of conservation biology at the University of British Columbia Okanagan. She has long-standing interests in forest wildlife and how they react to habitat loss and fragmentation. She is also interested in how scientific research informs conservation policy and decision-making, including species listings and Critical Habitat designations.