

Species Listing under Canada's Species at Risk Act

C. SCOTT FINDLAY,†§ STEWART ELGIE,* BRIAN GILES,‡ AND LINDA BURR‡

†Department of Biology and Institute of the Environment, University of Ottawa, 555 King Edward Avenue, Ottawa K1N 6N5, ON, Canada, email findlay@uottawa.ca

*Faculty of Law and Institute of the Environment, University of Ottawa, 555 King Edward Avenue, Ottawa K1N 6N5, ON, Canada

‡Institute of the Environment, 555 King Edward Avenue, University of Ottawa, Ottawa K1N 6N5, ON, Canada

Abstract: *In a preliminary analysis of listing decisions under Canada's Species at Risk Act (SARA), Mooers et al. (2007) demonstrated an apparent bias against marine and northern species. As a follow-up, we expanded the set of potential explanatory variables, including information on jurisdictional and administrative elements of the listing process, and considered an additional 16 species recommended for listing by SARA's scientific advisory committee as of 15 August 2006. Logistic model selection based on Akaike differences suggested that species were less likely to be listed if they were harvested or had commercial or subsistence harvesting as an explicitly identified threat; had Department of Fisheries and Oceans (DFO) as a responsible authority (RA); were located in Canada's north generally, and especially in Nunavut; or were found mostly or entirely within Canada. Subsequent model validation with an independent set of 50 species for which a listing decision was handed down in December 2007 showed an overall misclassification rate of <0.10, indicating reasonable predictive power. In light of these results, we recommend that RAs under SARA adopt a two-track listing approach to address problems of delays arising from extended consultations and the inconsistent use by the RAs of socioeconomic analysis; consider revising SARA so that socioeconomic analysis occurs during decisions about protecting species and their habitats rather than at the listing stage; and maintain an integrated database with information on species' biology, threats, and agency actions to enable future evaluation of SARA's impact.*

Keywords: biodiversity, endangered species, legislative amendment, listing, responsible authority, socioeconomic analysis, Species at Risk Act

Lista de Especies en el Contexto del Acta de Especies en Riesgo de Canadá

Resumen: *En un análisis preliminar de las decisiones de listados en el contexto del Acta de Especies en Riesgo de Canadá (AER), Mooers et al. (2007) demostraron un aparente sesgo contra especies marinas y septentrionales. Como un seguimiento, expandimos el conjunto de posibles variables explicativas, incluyendo información sobre elementos jurisdiccionales y administrativos del proceso de listado, y consideramos 16 especies adicionales recomendadas para ser enlistadas por el comité científico consultivo de AER hasta el 15 de agosto de 2006. La selección del modelo logístico basado en diferencias Akaike sugirió que las especies tenían menor probabilidad de ser enlistadas si eran cosechadas o si una amenaza identificada explícitamente era la explotación comercial o de subsistencia; tenían al Departamento de Pesquerías y Océanos (DPO) como autoridad responsable (AR); se localizaban en el norte de Canadá, especialmente en Nunavut o se encontraban principal o completamente dentro de Canadá. La validación subsiguiente del modelo con un conjunto independiente de 50 especies para las que las decisiones de enlistado fueron dadas a conocer en diciembre de 2007 mostró una tasa de error en la clasificación de <0.10, lo que indica un poder predictivo razonable. A la luz de estos resultados, recomendamos que las AR bajo el AER adopten un método de dos opciones para abordar los problemas en los retrasos derivados de consultas extendidas y el uso inconsistentes de las AR de los análisis socioeconómicos; que se considere la revisión de AER para que haya análisis socioeconómico durante la toma de decisiones sobre la protección de especies y sus hábitat y no en la etapa de enlistado; y mantener una base de datos integral con información sobre la biología de las especies, amenazas y acciones que permita la futura evaluación del impacto de AER.*

§Address correspondence to C. S. Findlay

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Palabras Clave: acta de Especies en Riesgo, análisis socioeconómico, autoridad responsable, biodiversidad, enmienda legislativa, especies en peligro

Introduction

In 2002 Canada passed its Species at Risk Act (SARA), which adopted an innovative approach to species listing that was intended to strengthen the role of science in listing decisions and provide transparency when political considerations override scientific rationales for listing. Effective implementation of SARA's provisions could substantially improve the survival prospects of imperiled Canadian species. Insofar as listing is an essential prerequisite to protection under SARA, an important issue is the factors that determine whether a species will indeed be listed.

Under SARA, a government-appointed body of wildlife experts (Committee on the Status of Endangered Wildlife in Canada or COSEWIC) assesses the status of species in various risk categories ranging from "extinct" to "special concern." These assessments are passed to the Minister of Environment, who either forwards them to the federal Governor in Council (GIC; name of Canada's cabinet) for a listing decision or sends the assessments for an extended process of consultation whereby a decision on listing is postponed pending further consultation with designated stakeholder groups. Once the assessments are passed to the GIC, it has 9 months to respond to COSEWIC's recommendation by either listing, rejecting outright (not list), or not listing at the current time but referring back to COSEWIC for further information. If a species is not listed, the rationale for not listing must be published in the *Canada Gazette*, a public forum. This requirement is meant to provide transparency and accountability when political listing decisions differ from scientific recommendations.

The effectiveness of the U.S. Endangered Species Act has been assessed using a wide range of indicators (e.g., Tear et al. 1993; Rachlinski 1997; Greenwald et al. 2006). The best biological indicators are population trends (Male & Bean 2005; Taylor et al. 2005), but given that SARA has been in force only 5 years, such an analysis at this stage is premature. But as a first step, Mooers et al. (2007) conducted a preliminary analysis of listing decisions under SARA and found a reduced likelihood of listing for marine fishes and terrestrial mammals, harvested species, and species with a northern distribution. They speculated that this apparent bias against marine and northern species was a result of deficiencies in the cost-benefit analyses that precede listing decisions and the Canadian government's reluctance to list commercially valuable species. We extended the analysis of Mooers et al. by expanding the set of species and explanatory variables

considered, using the expanded set of variables to derive a statistical model that best explains patterns of listing, assessing the predictive value of the model through independent validation with a second set of decisions handed down in 2007, and assessing the extent to which stated reasons for not listing a species were consistent with factors identified in the modeling exercise.

Building on Mooers et al. our objective was to provide insight into the success of SARA's innovative listing process and, based on our results, suggest revisions to SARA that could enhance its effectiveness. To that end, we addressed three questions: How often are scientific recommendations for species listing followed under SARA? What are the main factors that correlate with the decision not to list a species? And how might the listing process be revised to address those factors, and their underlying concerns, so as to improve the likelihood of achieving SARA's objectives?

Methods

We defined the binary response variable (listed/not listed) in three ways, depending on the nature of the decision not to list: the not-listed class included (1) only species rejected outright (NL); (2) both species rejected outright and those referred back to COSEWIC (NL[REF]); or (3) species rejected outright, referred back to COSEWIC, or sent to an extended consultation process (NL[REF, EP]). Although not explicitly authorized by SARA (SARA 2002; see section 27[1.1]), extended consultations take place when the listing of certain species "could have significant and widespread impacts on the activities of aboriginal peoples, commercial and recreational fishers, and Canadians at large" (Environment Canada 2005). Mooers et al. did not include the 16 extended consultation species in their analysis, presumably because a decision at the time was (and still is) pending. By contrast, we defined the three different sets of species that were not listed to ascertain whether additional insight might be obtained by comparing important predictors for each.

We designed and populated a relational database that contained a number of candidate explanatory variables for all 202 species assessed by COSEWIC and forwarded to the GIC for a listing decision by 15 August 2006. The first set of variables was similar to that used by Mooers et al. and included information on species' listing status, taxon, and a range of geographic and exploitation variables: listing decision (list, not list, refer back to

COSEWIC, or send for extended consultation); listing status (e.g., endangered, threatened); taxon, according to COSEWIC designation; species northern range, a binary variable indicating whether a species' range included one or more northern territories (Yukon, Nunavut, or the Northwest Territories); species range in Canada, approximated by the number of provinces and territories in which the species is found; exploitation, indicating whether, on the basis of information in the latest status report, a species is commercially harvested; subsistence exploitation, indicating whether a species is harvested for subsistence, based on information in the latest status report; harvested, a composite variable indicating whether a species is harvested commercially or for subsistence (i.e., if a species was exploited commercially or for subsistence, it was considered harvested); and endemism, the extent to which a species is endemic to Canada (values: 1, found exclusively in Canada; 2, found mostly in Canada but with peripheral populations elsewhere; 3, found in Canada and elsewhere to a similar degree; 4, at the edge of its range in Canada; 5, extirpated from Canada).

The second set of variables, which were not considered by Mooers et al., provided information on jurisdictional and administrative elements of the listing process: (1) relevant minister(s) or agencies responsible for the listing decision (involvement or absence of Environment Canada, Parks Canada, and the Department of Fisheries and Oceans [DFO]; all of which are potential responsible authorities [RAs] under the SARA [section 2]), and (2) number of provincial or territorial endangered species laws under which the species was listed at the time of a listing decision by the GIC.

The third set of variables, also not considered by Mooers et al. represented potential threats to species as identified in the most recent COSEWIC status report. All were binary variables for which a nonzero value was assigned only when a threat was explicitly identified in the report. Identified threats included harvest owing to perceived nuisance; taking of specimens for scientific study; indirect take (e.g., bycatch); legal commercial, recreational, or subsistence taking (harvest [threat]); habitat loss or modification; diseases or parasites; competition with native or exotic species; climate change; pollution; poaching (i.e., illegal harvesting); predation; decreased genetic variability; human disturbance; and successional change. We distinguished between whether a COSEWIC status report stated a species was harvested (harvest in the first set of variables) and whether harvesting was explicitly considered a threat to the species (harvest [threat]).

We adopted an information-theoretic approach to model selection (Burnham & Anderson 2002). We used forward and backward stepwise logistic regression to define a candidate set of linear models, at each step calculating the Akaike information criterion corrected for sample size (AIC_c) and with alpha set at 0.10 for variable

inclusion or removal. For each class of not-listed species, this procedure defined a set of candidate models for both selection procedures, from which we derived the AIC_c range (Δ) for the candidate model set. We then calculated the Akaike difference (Δ_i) for each model in this candidate set. Final selection was then based on Δ_i and Burnham and Anderson's (2002) rule of thumb for levels of empirical support.

There are a number of taxa (e.g., birds, reptiles, amphibians) for which all or almost all species are listed (Mooers et al. 2007), which induces a separation or quasi-separation problem in logistic regression. To circumvent this problem, we used the SPlus library `logistf` (Heinze & Ploner 2003), which implements a version of Firth's (1993) penalized log-likelihood to generate parameter estimates, standard errors, penalized log likelihoods, and profile penalized likelihood confidence intervals. Final selected models fitted to decisions rendered by August 2006 were then used to predict listing outcome and to estimate model predictive power for 50 species assessed by COSEWIC and forwarded to the GIC for a listing decision in December 2007.

Finally, we compared the minister's published reasons for not listing with the predictive factors identified through the model-fitting, selection, and validation exercise. If published reasons for not listing corresponded to important modeled predictors of listing decisions, this would suggest SARA's transparency provision was having the desired effect.

Results

Factors Predicting Listing

As of 15 August 2006, 434 species were recommended by COSEWIC for listing, of which 232 were automatically listed under SARA when it came into force. Of the remaining 202 species, 156 were listed, 20 were rejected outright (NL), 10 were referred back to COSEWIC (REF), and 16 were sent to extended consultation (EP), giving rise to three overlapping not-listed categories: NL, NL(REF), and NL(REF,EP). As Mooers et al. note, there were major taxonomic differences in the probability of listing ranging from zero for marine fishes to one for herpetofauna and birds (Fig. 1). Most of the observed taxonomic variation arose from the substantially reduced probability of listing for freshwater fishes ($\beta_{NL(REF, EP)} = -3.15$, LR $\chi^2 = 9.62$, $p < 0.001$), marine fishes ($\beta_{NL(REF, EP)} = -6.52$, $\chi^2 = 28.8$, $p < 0.001$), marine mammals ($\beta_{NL(REF, EP)} = -2.97$, $\chi^2 = 7.90$, $p < 0.001$), and terrestrial mammals ($\beta_{NL(REF, EP)} = -3.39$, $\chi^2 = 8.86$, $p < 0.001$) compared with birds, herptiles, and plants (Fig. 1). For NL(REF) and NL(REF, EP), but not NL, marine fishes, marine mammals, and terrestrial mammals, but not freshwater fishes, had a substantially reduced likelihood of listing.

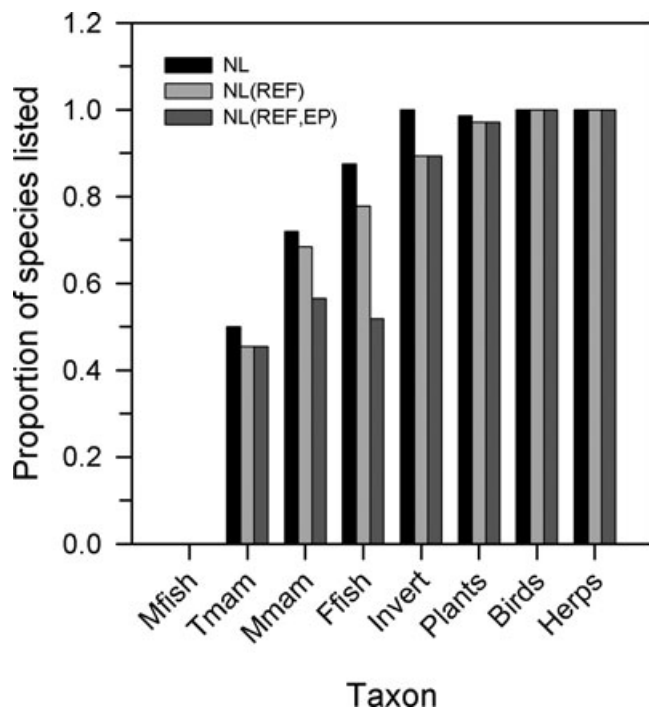


Figure 1. Proportion of listed marine fishes (Mfish), terrestrial mammals (Tmam), marine mammals (Mmam), freshwater fishes (Ffish), invertebrates (Invert), plants and mosses (Plants), birds (Birds), and reptiles and amphibians (Herps). These proportions are computed differently depending on the definition of not listed. Shown are the proportions when not listing is defined as rejected outright (NL); rejected outright or referred back to COSEWIC (NL[REF]); and rejected outright, referred back, or deferred to an extended consultation process (NL[REF, EP]).

For all three classes of not-listed species (NL, NL[REF] and NL[REF, EP]), few fitted models showed substantial support (Table 1), irrespective of the fitting procedure. In all cases, final selected models showed negative partial associations with four variables: harvested commercially or for subsistence or harvesting an important threat; DFO as RA; northern distribution; and endemism such that species whose range was entirely in Canada were least likely to be listed (Table 2; Fig. 2). For NL(REF, EP), species for which poaching was identified as a threat were also less likely to be listed (Table 2). In all cases, support for the final selected model dramatically exceeded that of a purely taxonomic model, and in no case did the addition of taxon substantially improve fit above that of the final selected model.

The independent effects of poaching and geographical distribution may represent residual taxonomic effects. For example, although 72% (28 of 39) of species found only or mostly in Canada were mammals and fishes, only 13% (17 of 127) of species on the periphery of their

range or extirpated in Canada were mammals or fishes: most were plants, birds, or herptiles, all of which had dramatically higher listing rates (Fig. 1). Similarly, mammals and fishes represented 77% (14 of 18) of poached species and only 33% (60 of 184) of species for which illegal take was not explicitly identified as a threat.

Like Mooers et al., we found that harvested species were considerably less likely to be listed. Subsistence harvest was a particular threat: of the 21 species forwarded to the GIC that were subsistence harvested, only three were listed, and all were listed as special concern, the lowest risk level. The remaining 18 species were either not listed (12), referred back to COSEWIC (2), or sent to extended consultations (4). Commercially harvested species, which may also be subsistence harvested, were also less likely to be listed by the GIC.

Of northern species found in the Yukon or Northwest Territories, but not Nunavut, four of six were listed (one was rejected and one was referred back to COSEWIC). By contrast, of the 10 species found in Nunavut, none were listed: 9 were rejected outright and one was sent to extended process. Substitution of Nunavut as a binary predictor for northern in the final selected models in Table 2 resulted in a substantial improvement in fit of the selected model ($\Delta_i = 9.8, 5.2$ and 4.1 for NL, NL[REF] and NL[REF,EP], respectively), but inclusion of both northern and Nunavut did not. This suggests that much of the northern effect was attributable to a very low likelihood of listing for species found in Nunavut.

Our analysis also identified RA—a factor not considered by Mooers et al.—an important independent predictor of listing decisions. In cases where DFO was, in whole or in part, the RA, the likelihood of listing was reduced irrespective of how not listed was defined, but was particularly pronounced when species sent to extended consultation were considered not listed (Fig. 2 & Table 2).

The probability of listing was not related to COSEWIC status (extirpated species were excluded because of small sample size). When the GIC listed a species, the listing status was the same as that recommended by COSEWIC, except in the case of three species whose status was revised by COSEWIC following its initial recommendation. For all other candidate variables, there was little evidence of an association with listing.

As of August 2006, 16 species were undergoing extended consultations, and in all cases DFO was the RA. Of the 186 species forwarded to the GIC for listing decisions, 26 had previously gone through extended consultations. In all but one case (polar bear [*Ursus maritimus*]), DFO was the RA. Of those 26 species, six (23%) were subsequently listed, 12 were not listed, and eight were referred back to COSEWIC. In contrast, 150 of the 160 species (94%) that did not go through an extended process were listed. This suggests extended consultation is a significant risk factor for a decision not to list.

Table 1. Factors retained in final selected models for the three different categories of decisions not to list.*

Factor	Categories of decisions not to list		
	rejected outright (NL)	rejected outright or referred back (NL[REF])	rejected outright, referred back, or extended consultation (NL[REF, EP])
Harvest (threat)			-2.36; [-3.75, -1.10]; 0.09
Harvest	-2.61; [-4.29, -1.02]; 0.07	-2.24; [-3.54, -1.06]; 0.11	
Northern	-1.91; [-3.92, 0.067]; 0.15	-2.23; [-3.83, -0.76]; 0.11	-1.97; [-3.59, -0.49]; 0.14
DFO	-1.82; [-3.66, -0.27]; 0.16	-1.32; [-2.66, -0.10]; 0.27	-2.45; [-3.78, -1.38]; 0.09
Endemism	0.69; [0.02, 1.35]; 1.97	1.08; [0.54, 1.70]; 2.94	0.67; [0.20, 1.16]; 1.95
Poaching			-2.32; [-4.05, -0.70]; 0.10

*Factors: harvesting is considered a significant threat (harvest[threat]); species is harvested commercially or for subsistence (harvest); species has a northern distribution (Northern); Department of Fisheries and Oceans is a responsible authority (DFO); proportion of the species' range found within Canada (endemism); and poaching is identified as a potential threat (poaching). Cell entries are estimated partial regression coefficients for the final selected model; upper and lower CIs for estimated coefficients (in brackets); and odds ratio.

Of the 50 test species for which GIC decisions were rendered in December 2007, 14 were not listed owing to designation for extended process, one was referred back to COSEWIC, and the rest were listed. Hence, within this model-testing set, there was no significant variation in either NL or NL(REF). For NL(REF, EP), the selected model in Table 2 produced generally good predictions (overall misclassification rate = 10% [5 of 50] based on logistic cutoff = 0.50). Misclassified species, all of which were predicted to be listed but were not, included two species of mussels, one reptile, one bird, and one lichen, all five of which had predicted scores far removed from the logistic cutoff (range = 0.753-0.98). In comparison, overall misclassification rate for the initial data set was 5% (10 of 202), and misclassification rates were higher for unlisted versus listed species (7 of 46 = 15% vs. 3 of 156 = 2%). Three species had predicted scores very close to the cutoff (range 0.51-0.55). Poor model predictions were obtained for the remaining seven species (range: 0.18-0.98), all of which were not listed.

Reasons for Not Listing

We compared the minister's published reasons for not listing a species with the predictive factors identified through the modeling exercise. In most cases (80% [16 of 20]), "process" reasons were cited as a rationale for not listing. In 50% of decisions not to list, process was the only cited reason. Of the 16 species not listed for which process reasons were cited, the process in 10 of 16 cases was ongoing consultation with aboriginal groups. In the remaining six cases, the species was considered already protected through federal or provincial legislation or other initiatives.

Negative socioeconomic impacts were also cited as reasons for not listing in 50% (10 of 20) of cases. For only one species, negative impacts were apparently confined to a single sector. In all other cases, at least two negative impacts were cited. In 45% (9 of 20) of cases, the negative impact was on commercial or industrial activity, and in 35% (7 of 20) of cases negative impacts on data collection, management, or monitoring were cited (e.g., by

Table 2. Fitted logistic regression models with some empirical support (Akaike differences [Δ_i] < 8.0), including Akaike range (Δ) for the candidate set, corrected Akaike information criterion (AIC_c) and associated change relative to the best model (Δ_i).

Response ^a	Δ	Model ^b	AIC_c	Δ_i
NL	59	H, N, DFO, E	46.2	0
		H(T), N, DFO, E	49.2	3.0
		H, N, P	51.2	5.0
NL(REF)	66	H, N, DFO, E	73.7	0
		H(T), N, DFO, E	76.4	2.7
		H, N, P	77.1	3.4
NL(REF,EP)	99	H(T), N, DFO, E, P	94.7	0
		H, N, DFO, E	101.8	7.1

^aKey: NL, not listed; NL(REF), not listed or referred back to COSEWIC; NL (REF, EP), not listed, referred back to COSEWIC or sent for extended consultation process.

^bModel variables: H, harvest; H(T), harvest (tbreat); N, species with a northern range; DFO, Department of Fisheries and Oceans; E, range within Canada or endemism; P, poaching.

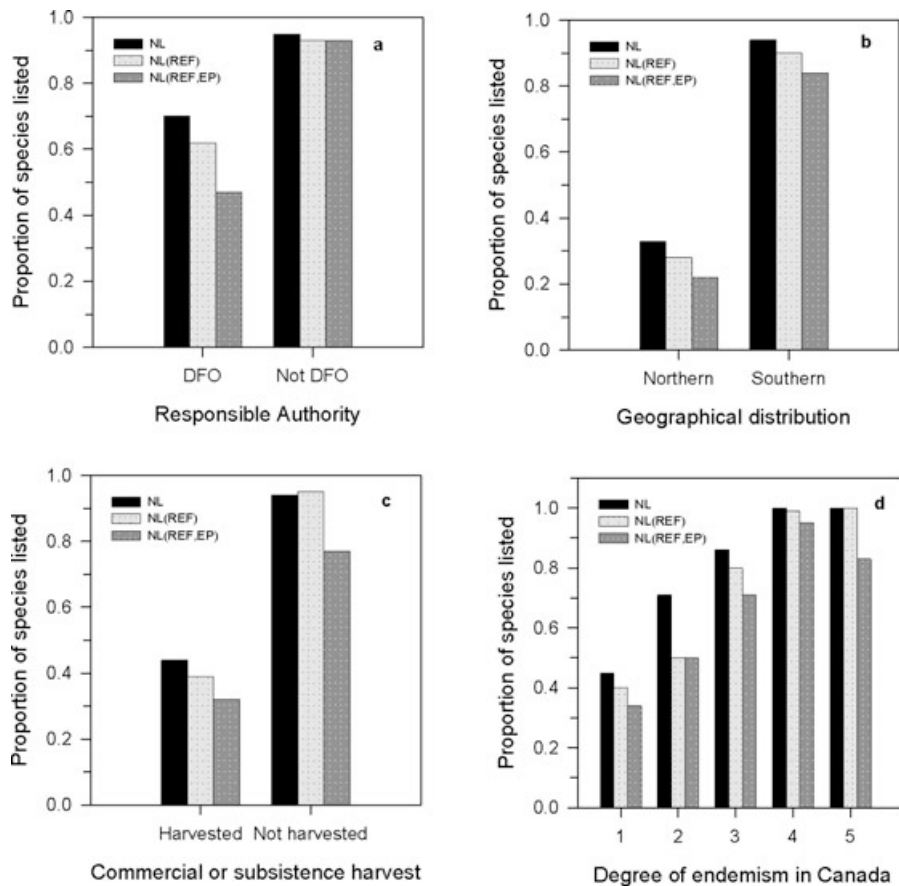


Figure 2. The relationship between the probability of listing and (a) responsible authority (Department of Fisheries and Oceans [DFO] vs. another authority), (b) geographical distribution (northern vs. southern), (c) exploitation (harvested vs. not harvested), and (d) degree of Canadian endemism (range 1–5: 1, species found exclusively in Canada; 2, species found mostly in Canada but with peripheral populations elsewhere; 3, species found in Canada and elsewhere to a similar degree; 4, species at the edge of its range in Canada; 5, species extirpated from Canada) for the three different not-listed categories (NL, rejected outright; NL[REF], rejected outright or referred to [COSEWIC]; NL[REF, EP], rejected outright, referred back to COSEWIC, or deferred to extended consultation.

causing reduced reporting of bycatch). Scientific issues (e.g., difficulty in delineating the at-risk populations or subpopulations) were cited as a reason for not listing in 6 of 20 cases.

Although the sample size of unlisted species was too small to permit robust conclusions, the minister's published reasons for not listing are consistent with our modeling results: all 10 species for which negative socioeconomic impacts were cited as a reason for not listing are harvested and all 10 of the species for which ongoing aboriginal consultation was cited as a reason for not listing are found in Nunavut.

Discussion

By significantly expanding the set of candidate explanatory variables and using a rigorous model development and validation approach, our analysis extended that of Mooers et al. in several important ways.

Taxon as a Predictor of Listing Outcome

Although Mooers et al. document substantial taxonomic variation in the likelihood of listing, none of our final models retained taxon as a predictor, probably because of the strong partial correlations between taxon and other

variables. As Mooers et al. show, most taxonomic variation in listing arises from the comparatively low listing probability for marine mammals and fishes, all of which have DFO as an RA. Moreover, as Mooers et al. point out, the proportion of harvested species is far higher in these taxa and terrestrial mammals. We infer that much of the taxonomic bias Mooers et al. document is a reflection of taxonomic variability in RA and the prevalence of commercial or subsistence harvesting.

Responsible Authority and the Consultation Process

We found that RA was an important predictor of a species not being listed. Mooers et al. suggest the apparent bias against harvested and northern species reflects in part "a reluctance by . . . the Department of Fisheries and Oceans to accept the additional stewardship responsibilities required by SARA." Our analysis showed, however, that DFO was an important predictor even when other variables were controlled. This implies that the DFO effect was not simply because DFO is responsible for a larger proportion of species that are harvested or have a northern distribution.

Much of the RA signal seemed to arise from the clear difference between Environment Canada and DFO in the probability that a species was not listed either because it was going through or had previously gone through an

extended consultation. For all 16 species in extended process, DFO was the RA either solely or in part. Insofar as former extended consultations are themselves a risk factor for a species not being listed – 77% of such species are eventually rejected for listing – the greater prevalence of extended processes undertaken by DFO compared with Environment Canada resulted in a greater likelihood of not being listed.

Stratos (2006), in a review of SARA's implementation, notes that "Environment Canada and Fisheries and Oceans appear to take different approaches with respect to socioeconomic analysis. Fisheries and Oceans Canada undertakes socioeconomic analysis and cost-benefit analysis to support listing decisions concerning aquatic species. Environment Canada, on the other hand, has not undertaken such analysis to support listing decisions and some officials interviewed consider that socioeconomic analysis should be incorporated at a later stage, into the development of Action Plans for listed species." Taken together, these results strongly suggest the two major RAs have hitherto adopted different approaches to listing, which have led to different outcomes.

The approach of undertaking a cost-benefit analysis prior to listing decisions appears to be inconsistent with SARA's overall scheme. The act requires a thorough, two-stage recovery planning process for all listed species, which includes identifying critical habitat, setting recovery targets, proposing measures to protect species and habitat, analyzing the costs and benefits of those measures, engaging stakeholders and experts, and public comment (SARA s.39, 41, 48–50). This process requires several years and is designed to ensure that protection decisions are made in an informed manner. A cost-benefit analysis at the listing stage, of necessity, does not involve the same level of information, analysis, or public engagement. It is also highly speculative because it is made without knowledge of what protection actions are being proposed. It seems incongruous that a decision not to list a species—which is, in effect, a decision to undertake no protection or recovery actions under SARA—is being made in a much less thorough, informed, and transparent manner than is required for deciding what types of protection and conservation measures to undertake.

Government procedures require listing proposals be accompanied by a regulatory impact assessment statement (RIAS; Privy Council Office 2008), which assesses the costs and benefits of the proposed action. (Moors et al. discuss the RIAS process and proposed changes.) But it is one thing for a RIAS to simply assess the costs arising from a listing decision per se, which are comparatively small (mainly the cost of preparing a recovery strategy and action plan). It is, however, quite another for a RIAS to seek to estimate the (potentially far greater) costs that could arise from protecting and recovering a species and its habitat because those decisions are still months or years away, and the costs could vary widely

depending on how government exercises its discretion. One exception is the cost associated with restrictions on harvesting a species, which to some extent flow from a listing decision.

Harvested Species and Socioeconomic Consequences

Our results and those of Moors et al. showed commercial harvest was a significant predictor of not listing. Twenty-three of 36 commercially harvested species were not listed. This finding is troubling because overexploitation is the second-most common threat (after habitat loss) to species at risk in Canada and "the most prevalent threat for marine mammals and marine fishes" (Venter et al. 2006). Bycatch, in particular, affects 78% of endangered marine fishes and is the most important cause of overexploitation for these taxa (Venter et al. 2006).

The significance of harvest in decisions not to list a species is likely due, at least in part, to the structure of SARA. The only automatic protection that directly follows from listing is a prohibition on direct harm to a species or its residence (sections 32 and 33). Other protection decisions, including habitat protection, are postponed to the recovery planning stage. The act allows for permits to authorize incidental harvest (e.g., bycatch), but only where "the activity will not jeopardize the survival and recovery of the species" (section 73[3]). As such, it is legitimate at the listing stage for an RA to consider the socioeconomic consequences of harvest restrictions and, more specifically, to consider whether it is possible to restrict harvest of a species in a manner that is consistent with the species' survival without imposing unacceptable socioeconomic costs. This appears to be exactly what was considered in some of the decisions not to list harvested species such as the Cultus and Sakinaw populations of Pacific sockeye salmon (*Oncorhynchus nerka*); the only way to protect these populations was to avoid fishing comparatively healthy sympatric stocks.

Nunavut and Aboriginal Consultation

Species with a northern distribution had a significantly reduced probability of listing. Moors et al. suggest this may be due to RA requirements for consultation with northern wildlife management boards (WBMs), whose membership includes significant aboriginal representation. Our results suggest this northern effect is primarily a Nunavut effect. This distinction is important because there are also WBMs and significant aboriginal populations in the Yukon and Northwest Territories, yet there is no evidence of lower listing rates for species in those two territories. Anecdotal evidence suggests the Nunavut effect may be a Nunavut Wildlife Management Board effect (a co-management board created pursuant to land-claims agreement), which has expressed concern about federal listing of species in its territory (Government of Canada 2006).

Implications for SARA and SARA Assessment

It is problematic that SARA's structure leads to decisions about the socioeconomic consequences of harvest restrictions being made at the listing stage, where failure to list implies no protection under the act. The implication is that a very consequential decision is made through a summary process, with limited time, information, and opportunity for public input. This problem could be avoided by revising SARA to decouple decisions about listing from decisions about harvest restrictions. Nevertheless, until such amendments are made, the best solution may be a two-track listing process. In this way, listing decisions normally would be made in the legislated 9-month window, with only a summary cost-benefit analysis. Nevertheless, where an RA proposes not to list a species, a more thorough process could be required before a final decision. In other words, given the potentially dire consequences of not listing, it should involve a more extensive, well-informed, and participatory process, such as that required under the U.S. Endangered Species Act (U.S. ESA 1973 subsections 7[e]-[h]) or Ontario Endangered Species Act (Ontario Endangered Species Act 2007, section 57).

The Nunavut effect, which arises from protracted extended consultations and results in a high likelihood of not listing, points to two main flaws in SARA's structure and implementation. First, SARA does not allow for permits to authorize any aboriginal harvest of endangered or threatened species, even when this can be done in a limited way without compromising species survival. Such permits were recommended by the federal Endangered Species Task Force (Environment Canada 1996) and should be considered for inclusion in SARA because this may help ameliorate some of the tensions that lead to decisions not to list. Second, Canada's Constitution requires consultation before making decisions that will affect aboriginal people (*Haida Nation v. British Columbia* 2004), as pointed out by Mooers et al. Nevertheless, it does not stipulate that aboriginal rights override all other values or justify lengthy delays. In particular, Canada's Supreme Court has explicitly stated that wildlife conservation can, and often will, take precedence over aboriginal use rights (*Regina v. Sparrow* 1990).

Aboriginal consultation must be taken seriously, and it should be carried out in a timely way, with a genuine attempt to accommodate aboriginal interests. But such accommodation should rarely require that a species not be listed; rather, it can usually be achieved through appropriate harvest restrictions or habitat-conservation measures following listing. We suggest, therefore, that SARA be revised to allow permits for limited aboriginal harvest of listed species, where harvest is consistent with the species' survival and recovery, and there should be reasonable time limits on extended aboriginal consultations, consistent with constitutional and treaty rights.

If the above recommendations are adopted, the need for political discretion at the listing stage would be greatly diminished because the socioeconomic concerns that necessitate such discretion could be addressed elsewhere in the process. As such, it may be advisable to revise SARA so that listing decisions are made on a strictly scientific basis, as is done under provincial endangered species legislation in Ontario and Nova Scotia. Other considerations would then be deferred to subsequent stages of the process (i.e., protection and recovery), although even there it is important that socioeconomic and political concerns be appropriately addressed (e.g., Scott et al. 1995).

In the absence of such changes, we suggest a two-track listing process. Listing decisions normally should be made in the legislated 9-month window, without extensive cost-benefit analysis; however, if an RA proposes not to list a species, then a more extensive, informed, and participatory process should be required before a final decision. This would avoid the use of extensive cost-benefit analyses at the listing stage in most cases (such socioeconomic concerns are better addressed in the recovery planning process) and would ensure that decisions not to list (which can mean extinction or extirpation) are made only after a very thorough assessment. Moreover, extended consultations should be eliminated except in two instances: where required for purposes of aboriginal consultation (and then with time limits) and when an RA proposes a decision not to list, as per the preceding recommendation.

Our analysis and the long history of analysis of the U.S. ESA (e.g., Clark & Harvey 2002; Norris 2004) points to the importance of the design, population, and maintenance of integrated and accessible databases, which include information on species assessment and records of agency and regulatory actions (Scott & Goble 2005). With respect to SARA, we have begun this process and have built on this work. Responsible authorities should develop and maintain an integrated database that includes species attributes and records of institutional actions. Without such a database, ongoing comprehensive and rigorous evaluation of SARA's effectiveness and subsequent evidence-informed amendment will be difficult.

Conclusion

Taken together, our results and those of Mooers et al. provide a preliminary assessment of the success of Canada's approach to listing and protecting species at risk under SARA. On the positive side, leaving final listing decisions to politicians has not resulted in widespread failure to list scientifically recommended species. Most species recommended for listing by COSEWIC were listed (from 77% to 88%, depending on which definition of not listing was used). It is likely that this high percentage is due at least

in part to the transparency and timing requirements in SARA (Elgie 2008). Moreover, the attempt to increase transparency by requiring the GIC to publish its reasons for not listing appears to have been successful, insofar as the cited reasons for not listing a particular species were consistent with the factors identified as important predictors of listing outcomes.

On the other hand, 12–23% of recommended species were not listed. This is cause for concern because these species then do not receive any of the additional protections provided by SARA and (presumably) face a much greater risk of extinction or extirpation. Here, building on Mooers et al., we identified the main factors that influence decisions not to list a species—namely, administrative, regional (Nunavut), and socioeconomic factors. The prevalence of these nonbiological factors in the listing process reflects the structure of SARA and its implementing procedures. We have suggested ways in which SARA or its implementation could be revised to reduce the prevalence of decisions not to list or to require that these decisions be made in a more informed, thorough manner. This is important given the serious consequences often associated with not listing a species, namely, a significant reduction in its chance of survival.

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