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Expressing citizen preferences on endangered wildlife for building socially appealing species recovery policies: A stated preference experiment in Quebec, Canada

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ABSTRACT

Over the past fifty years, the world's wildlife populations have drastically declined. This stems from multiple causes, including the loss of natural habitat, which plays a vital role. Effective strategies to help endangered wildlife species recovery requires broad public support to be politically viable. In this study, we conducted a randomized survey to elicit and describe the Quebec population's preferences and concerns regarding endangered wildlife and estimate its willingness-to-pay (WTP) for their recovery. We used stated preference approaches, namely a discrete choice experiment (DCE) and best-worst scaling (BWS), to estimate WTP and rank respondent preferences towards categories of wildlife species and recovery program attributes. In the selection of animals listed, results also reveal strong public preferences for large mammals, more specifically the beluga whale and woodland caribou. Simulation exercises from our DCE results show that a quarter of respondents would be willing to pay $160 per year for a megafauna recovery program compared to $12 for birds, or insects, or fish and molluscs recovery programs. Despite respondents' strong preferences for the protection of megafauna, BWS and DCE simulation results indicate that a broader multispecies approach would be favoured by a larger segment of the population than a single specie approach. The survey results also revealed that the public likes to spend time in nature and is both concerned about endangered wildlife and aware of the interdependence between humans and nature. Therefore, our findings suggest that policymakers have a social acceptance to use both flagship species and multispecies approaches to implement endangered species recovery strategies. Moreover, our findings and the related literature on the value of ecosystem services indicate that communication on wildlife conservation could be buttressed by emphasizing conservation's contributions to ecosystem services.

1. Introduction

Biodiversity loss has reached crisis proportions (Barnosky et al., 2011; Ceballos et al., 2015) and reversing this loss is one of humanity's greatest challenges. Over the past five decades, the world's populations of vertebrates - birds, fish, mammals, amphibians and reptiles - have declined by an average of 68 % (Bradshaw et al., 2021). Although more difficult to quantify, the decline of invertebrates is often unnoticed or even begins before the species are inventoried (Eisenhauer, Bonn, & Guerra, 2019). In 2019, the International Panel on Biodiversity and Ecosystem Services (IPBES) estimated that around 1 million animal and plant species were threatened with extinction over the next decades (Díaz, Settele, Brondízio, Ngo, Guèze, Agard, & Zayas, 2019). The direct factors responsible are, in order of importance: land and sea use change; direct exploitation of organisms; climate change; pollution; and invasive alien species. In Canada, lost of natural habitat is the most important threat to endangered wildlife, disturbing 81.8 % of species (Woo-Durand et al., 2020).

Despite decades of alarming signals from scientists regarding the loss of biodiversity, global efforts to protect it have failed to reverse the trend. A number of researchers recommend using a pluralistic approach that seeks to understand human attitudes towards conservation and leverages different types of knowledge to improve the social acceptability and effectiveness of conservation strategies (Martín-López, Montes, & Benayas, 2007; Carmen et al., 2015). Stakeholder participation is increasingly recognized as a key building block in conservation planning

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(Bennett et al., 2017; Reed, 2008). Moreover, social interactions and political structures that contribute to the gulf between development and conservation need to be examined (Evans, Davila, Toomey, & Wyborn, 2017; Pascual et al., 2021; Young et al., 2013).

While the public does not have an in-depth knowledge of biodiversity conservation issues, public preferences can inform robust policy (Moran, McVittie, Allcroft, & Elston, 2007) that can withstand challenges from development stakeholders with little interest in wildlife conservation. In fact, opinion matters for policy makers as much as the legitimacy of scientists interested in safeguarding biodiversity (Garnett, Zander, Hagerman, Satterfield, & Meyerhoff, 2018). For local communities, the identification of endangered local flagship species can play a crucial role in encouraging a broader level of public support and engagement (Bowen-Jones & Entwistle, 2002). Moreover, endangered wildlife protection measures that take public preferences into account achieve greater efficiency and relevance (Robertson & Hull, 2001). In this context, this study provides policymakers with avenues for developing socially appealing policies that support the recovery of endangered species. Its objectives were to: 1) determine public preferences and concerns related to endangered wildlife and their habitats; 2) identify popular support for program characteristics (attributes) to facilitate communication and program planning, and 3) identify the population's willingness-to-pay for program characteristics.

To achieve our research objectives, we used stated-preference techniques, namely a discrete choice experiment (DCE)[1] and Best-Worst Scaling (BWS) to identify public preferences for endangered wildlife recovery programs. DCEs rely on randomized surveys to evaluate the target population's preferences and willingness-to-pay (WTP) for aspects or characteristics of goods or services under development, or public programs, projects, or policies for which no market exists. They can be used to evaluate trade-offs between aspects or characteristics of these goods, services, or public programs (Bateman, Carson, Hanemann, Hanley, Hett, Jones-Lee, & Loomes, 2002) and have recently gained considerable popularity in environmental evaluation (OECD, 2018). In that context, they have been used to value species, habitats, and protected areas (Christie et al., 2006; Dupras, Laurent-Luchetti, Revéret, & DaSilva, 2018; He, Dupras, & Poder, 2017; L'Ecuyer-Sauvageau et al., 2019; Rudd, 2009; Rudd, Andres, & Kilfoil, 2016). DCEs can be used to develop awareness campaigns or communication strategies. For example, they have been used in various socio-marketing campaigns to create effective outreach messages to promote forest management (Radler, Shaw, & Gorby, 2020), to reduce energy consumption (Sheau-Ting, Mohammed, & Weng-Wai, 2013), to market sustainable tourism products (Wehrli et al., 2017) and to promote environmentally friendly diets (Lombardi, Berni, & Rocchi, 2017).

Best-Worst scaling (BWS) experiment is based on random utility theory and was introduced by Louviere and Woodworth in 1990 (Louviere & Woodworth, 1990). It aims to determine the relative importance that individuals place on a set of attributes (Erdem, Rigby, & Wossink, 2012). In addition to being a valid tool for measuring individual preferences, its simplicity facilitates decision-making in a choice situation (Cohen, 2003). BWS is used in several fields of research, such as marketing, and social and environmental sciences (Dekhili, Cohen, & Sirieix, 2010; Pérez, Egea, & de-Magistris, 2019; Zander et al., 2021).

The remainder of the article is structured in four sections. Section 2 provides an overview of the study area and describes the experimental design and data collection. Section 3 reports the population's preferences and concerns according to the BWS and DCE results and the results of a simulation that explores the WTP for different wildlife recovery scenarios. Section 4 discusses the results and opportunities to use them to increase public awareness and act as a lever to finance endangered wildlife recovery programs. Section 5 concludes.

2. Study area and methods

2.1. Study area: The province of Quebec, Canada

The province of Quebec stands out for its large natural spaces, diverse forests, numerous rivers and lakes, fertile soils and mineral-rich subsoils. Because of its vast natural resources, primary production is one of the main engines of Quebec's economy, thus creating important tensions between traditional resource extraction and urban development and sprawl, and biodiversity conservation. A total of 17 % of Quebec's territory is protected, with 9 % located south of the 49th parallel, the richest Quebec area in terms of biodiversity (Réseau des milieux naturels protégés, 2021). Because of far greater human activity, the ecosystems located in Quebec's southern region face strong anthropogenic pressures, including the destruction of natural environments, the proliferation of invasive species, climate change and systemic pollution (Petit, Dupras, Gonzalez, Caillié, Auzel, Vaillancourt, & Lafortune, 2021).

In Canada, environmental laws and regulations are largely the responsibility of the provinces. In Quebec, the Ministry of Forests, Wildlife and Parks (MFWP) is responsible for the conservation of wildlife and their habitats. Despite MFWP actions (including knowledge acquisition) to protect their habitats, several wildlife species are endangered. In fact, Quebec has 20 wildlife species designated as threatened (apprehended disappearance) and 18 designated as vulnerable (survival considered precarious). In addition, 115 wildlife species are susceptible to be designated as threatened or vulnerable, for a total of 153 threatened, vulnerable or susceptible species (MFWP, n.d.). The complete list of species with status in Quebec is provided in Appendix A.

To strengthen conservation actions, MFWP is working on modernizing the *Regulation respecting wildlife habitats* (RRWF - (chapter C-61.1, r.18)). This modernization specifically aims to increase the protection of endangered species habitats located on private property, which is a particularly important element of biodiversity conservation in southern Quebec, where the bulk of private land and most endangered species are located. The results of this study can therefore be used to inform MFWP's conservation policy development and communication in a way that takes population preferences and concerns into account.

2.2. Survey development and administration

The survey used for this study included four sections. The first included typical questions of declared preference research in an environmental context, that is, questions that seek to discover respondents' preferences and concerns about nature and their practices towards or in nature. The second section included the BWS model to identify public preferences vis-à-vis ten species at risk. The third section consisted of the DCE experiment, which is discussed in detail in the next section. The final section consisted of demographic questions, so that the sample's demographic characteristics could be compared to those of the underlying population as revealed in the most recent census. The questionnaire was developed using Lighthouse Studio version 9.10.0 by Sawtooth Software Inc. Prior to the questionnaire being posted online, it was tested for comprehension by graduate students, postdoctoral fellows and MFWP representatives.

The online survey took place between January and February 2021. The survey was conducted by the survey firm LEO (LegerOpinion.com) and targeted a representative sample of the adult Quebec population. To obtain representativeness, we sought to obtain a balanced sample corresponding to the population on the basis of Quebec's rural/urban divide, and age, gender, income and education distribution. The initial number of respondents was 970. Once the data collection was complete, verification work was carried out to validate the quality of responses.

[1] DCEs are one of four choice modeling techniques that also include contingent ranking, contingent rating, and paired comparisons. Of the four methods, only DCEs satisfy the requirements of welfare theory (Bateman et al., 2002). Choice modeling is also referred to as conjoint analysis.

Data from the online survey was used if the respondent had completed the questionnaire. We used the RLH (Root Likelihood) cut-off approach discussed by Orme to identify random respondents in BWS exercises and DCEs (Orme, 2019). In addition, a questionnaire was also dropped if the respondent took less than six minutes to complete it. The triage exercise resulted in 880 usable responses. Given that respondents repeated the DCE exercise 10 times, the survey yielded 8,800 DCE observations.

2.3. The Best-Worst scaling (BWS) experiment

In this study's application of BWS, we used 10 attributes, which consisted of 10 endangered species co-selected by the MFWP and the research team. Species were selected based on the following criteria: status of the species, geographical distribution, ecosystem covered, familiarity and threats. Selected species and their status are listed in Table 1. We then determined other aspects of the BWS exercise, namely, the number of choice task per respondent (6), the number of attributes per choice card (5), and the number of questionnaire versions (20). In each of the six choice tasks, respondents had to select the attributes (species) they preferred the most and the least from the list of five presented. For each choice task, the five species were randomly selected from the list of 10. To ensure that each specie would be compared the same number of times to each of the other species, our BWS exercise had 30 versions. Fig. 1 presents an example of a choice card given to participants.

We would like to take your preferences into account in the implementation of future strategies for the protection of Quebec's precarious species and their habitats. Choose one species that you think is the most important and one species that you think is the least important from the list of 5.

For statistical reasons, you must do this exercise 6 times.
(1 of 6).

2.4. The discrete choice experiment (DCE)

The DCE exercise consisted of a series of 10 choice tasks. For each choice task, respondents were asked to choose from four options, including a status quo option. The status quo option was presented to respondents as a situation where nothing more is done than is already being done for the recovery of these species. To reduce the risk of hypothetical bias, respondents were presented with a cheap talk narrative prior to the exercise to describe the method and asked to be honest with their choice - that is, to choose options for which they are genuinely willing to pay for. According to Penn and Hu's meta-analysis, cheap talk reduced economic value estimates by around 20 % compared to baseline treatment without it (Penn & Hu, 2019), yielding more conservative WTP estimates than without the cheap talk narrative. The following cheap talk narrative was used in the DCE experiment:

Table 1
The 10 species used in the BWS exercise and their respective status.

Species	Latin name	Quebec status
Wood turtle	*Glyptemys insculpta*	Vulnerable
Copper Redhorse	*Moxostoma hubbsi*	Threatened
Beluga whale, St. Lawrence Estuary population	*Delphinapterus leucas*	Threatened
Woodland caribou, Forest-dwelling ecotype	*Rangifer tarandus caribou*	Vulnerable
Rusty patched bumble bee	*Bombus affinis*	Susceptible
Western chorus frog	Pseudacris triseriata	Vulnerable
Spring salamander	Gyrinophilus porphyriticus	Vulnerable
Golden eagle	*Aquila Chrysaetos*	Vulnerable
Barrow's goldeneye	*Bucephala islandica*	Vulnerable
Alewife floater	*Anodonta implicata*	Susceptible

Imagine that it is possible for you to contribute financially to a program to support the protection of endangered wildlife species and their habitats in Quebec. Recovery costs for these species can be funded with existing taxes or increased taxes. If their support is funded without raising taxes, it will compete for funding with other potential public projects you might support.
The following questions are designed to assess your willingness to pay annually to support additional recovery efforts for wildlife species at risk. This exercise comes in a series of 10 repetitive exercises. It begins with a choice to be made between three recovery scenarios and the situation where nothing more is done than is already done for the recovery of these species. It should be noted that the scenarios that will be presented to you for the entire exercise will all be different from each other.
For each of the choices that will be offered to you, you must compare the three scenarios to the current situation to then choose the one you prefer and that you would be ready to finance. If neither of the two recovery scenarios suits you, you can choose the current situation which does not involve any additional contribution. We remind you that these choices are hypothetical and do not require you to make a real commitment. Your choices will help us identify the aggregate preferences of participants and Quebecers with respect to the proposed scenarios. However, it is important to answer honestly as if you had to pay to increase the protection of Quebec's biodiversity.

The choice of attributes (and levels) was made by the research team and validated by MFWP staff. Attributes and their levels aimed to offer respondents different options to support the recovery of endangered species in Quebec. Among the attributes, three were non-monetary and one was monetary. The monetary attribute included five contribution levels ($10, $25, $50, $100, and $200). Attributes and their levels are presented in Table 2. A total of 12 questionnaire versions were generated by the softwarés algorithms. We applied the Sawtooth Software balanced overlap method (Orme & Chrzan, 2017) to reduce level overlap within individual tasks. Fig. 2 illustrates a choice set. System-generated choice sets were adjusted to ensure that payment levels were non-decreasing in the number of recovered species.

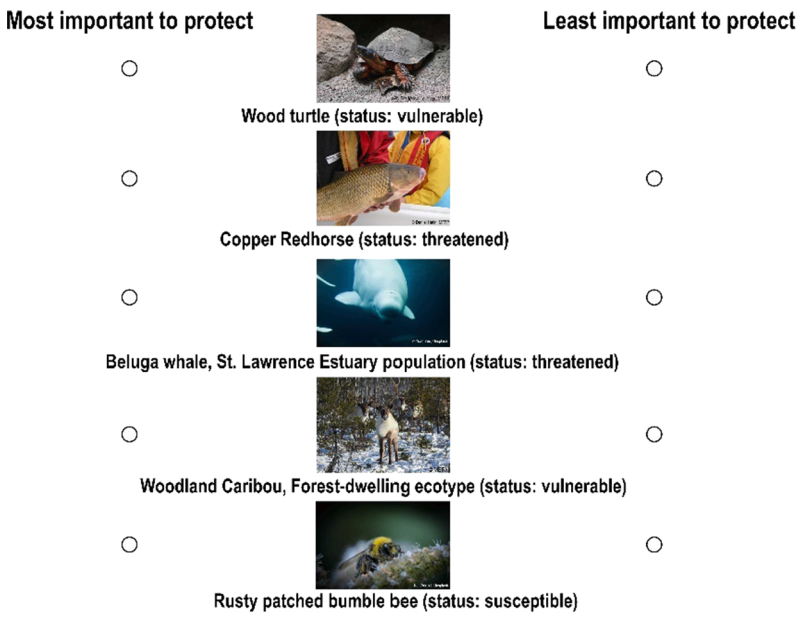
To support the recovery of species at risk in Quebec and their habitats, which of these options would you choose? The goal is to restore as many endangered species as possible over a 20-year period with the support of the population.

For statistical reasons, you must do this exercise 10 times.
(1 of 10).

2.5. Data analysis

Both DCE and BWS exercises were analysed using Hierarchical Bayes (HB) estimation from Lighthouse Studio 9.10.0 software. The term hierarchical refers to its characteristic of working at two different levels: the sample level and the individual level (Orme, 2000). At the individual level, this approach assumes that partial utility values are (random parameters) described by a multivariate normal distribution. At the sample level, it assumes that the probability of a respondent choosing one option among others is governed by a multinomial logit (Orme, 2000). These two levels allow the algorithm to "borrow" missing information from the individual level to the sample level (Orme & Chrzan, 2017). HB can therefore estimate individual and total part-worth utilities (Orme, 2000), otherwise known as relative importance scores (RIS).

In this study, we did simulations with both DCE and BWS results using Sawtooth Software Choice Simulator®. Simulations were used to maximize the preferences heterogeneity of our sample in order to propose communication and recovery program strategies. With BWS results, we performed simulations to put attributes (our ten species shown in Table 1) in competition with each other to determine the share of preference (%) for each (Orme, 2010). Afterwards we performed a Total Unduplicated Reach and Frequency (TURF) analysis. Commonly used in marketing, this optimization approach finds a subset of items that



Please note: Currently, 20 wildlife species designated as threatened (apprehended disappearance) and 18 designated as vulnerable (survival considered precarious). In addition, 115 wildlife species are susceptible to be designated as threatened or vulnerable, for a total of 153 threatened, vulnerable or susceptible species.

Fig. 1. Example of a BWS choice set.

Table 2
DCE recovery program attributes and levels.

Attributes	Levels
Number of recovered species in 2041	100
	75
	50
	25
Species category prioritized	Reptiles
	Fish and molluscs
	Birds
	Small mammals
	Amphibians
	Large mammals
	Insects
Area of intervention	Southern Quebec
	Northern Quebec
	Everywhere in Quebec
	In my region
Annual payment	$10
	$25
	$50
	$100
	$200
Status quo option	Refusal option

reaches the maximum number of respondents possible (Adler, Smith, & Dumont, 2010).

For the DCE results, we conducted six simulations, with each one using four species recovery scenarios plus the status quo (Table 9) to estimate the proportion of respondents (share of preference) who would choose between each of the five given scenarios. The simulator allows the definition of hypothetical scenarios, which then compete against each other (Orme, 2010). Using the Randomized First Choice method, the simulator estimates respondent choices between these scenarios, which are constructed from the experiment's attributes and their levels (Orme, 2010). The simulations allow us to estimate population preferences towards different recovery options.

Compared to a non-hierarchical multinomial logit analysis or a latent class model, HB estimation allows a greater accuracy for both individual choices and share estimation predictions (Orme, 2000; Hein, Goeken, Kurz, & Steiner, 2022). Results from HB estimations can then be used to perform simulations and, more importantly, increase choice share predictions accuracy (Hein et al., 2022).

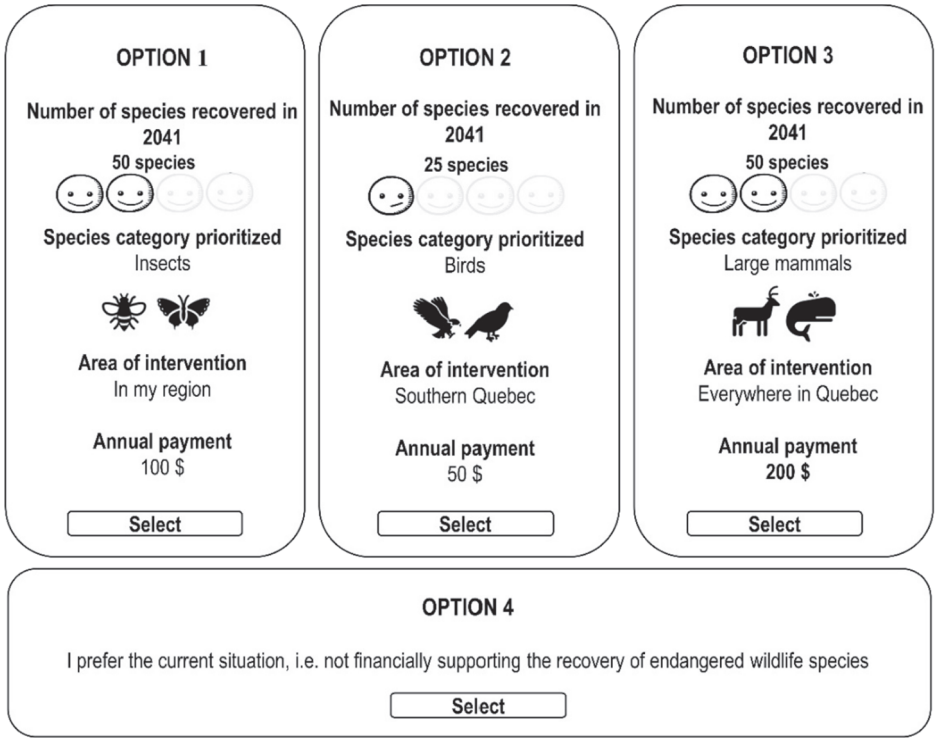
3. Results

3.1. Respondent and population socio-demographics characteristics

Table 3 provides a profile of respondent and the target population socio-demographic characteristics. Our sample is fairly representative of the Quebec population, with one exception. We note an over-representation of the more educated, quite a common phenomenon observed in on-line surveys conducted in Quebec (He et al., 2017; Lévesque et al., 2021).

Table 4 presents respondents' preferences towards nature and the activities they perform in nature. An overwhelming majority (97 %) of respondents enjoy spending time in nature. They visit different settings, including urban green space (82 %), forests (68 %), aquatic environments (62 %) and coastal environments (40 %). A quarter of them spend time in nature a few times a month while 21 % a few times a week.

Respondents who spend time in nature go hiking (71 %), walk or meditate (70 %), observe wildlife (44 %) and fish (20 %). The vast majority of respondents (79 %) are interested in and appreciative of wildlife. There is also a high degree of concern about the loss of wild animals in Quebec, with 65 % of respondents saying that they are very or extremely concerned, while 94 % are at least moderately concerned. We also asked respondents if they favor more or less government support or no change in support to protect endangered wildlife. The vast majority favor a little or much more support (88 %) with almost half (48 %) favoring much more support.



Please note: Currently, 20 wildlife species designated as threatened (apprehended disappearance) and 18 designated as vulnerable (survival considered precarious). In addition, 115 wildlife species are susceptible to be designated as threatened or vulnerable, for a total of 153 threatened, vulnerable or susceptible species.

Fig. 2. Example of a DCE choice set.

Table 3
Sample and population socio-demographic characteristics.

Demographic characteristic		Sample	Population[a]
Gender	Men	48 %	49 %
	Women	50 %	50 %
	Others	2 %	N/A
Age	18–19	2 %	3 %
	20–24	7 %	8 %
	25–34	16 %	16 %
	35–44	22 %	16 %
	45–54	22 %	18 %
	55–64	18 %	18 %
	65 +	17 %	21 %
	No answer	0 %	1 %
Total household annual ($) gross income	1–24,999	10 %	13 %
	25 k–49,999	21 %	21 %
	50 k–74, 999	21 %	19 %
	75 k–99,999	17 %	16 %
	100 k–199,99	23 %	26 %
	200 k +	3 %	5 %
	No answer	9 %	0 %
Education	High school diploma	18 %	39 %
	Vocational studies or college diploma	44 %	39 %
	Undergraduate degree	25 %	14 %
	Graduate degree	12 %	5 %
	No answer	1 %	1 %
N		880	172,465

[a] Quebec population 18+, 5% sample of the 2016 Canadian census.

3.2. Best-Worst scaling (BWS) results

The first column of Table 5 presents the HB estimation relative importance scores (RSI) of each specie from the BWS experiment. The RSI were rescaled to a 0–100 scale and sum up to 100, as it is easiest to interpret and present to the readers. RSI are arranged in descending order, revealing the relative preferences of respondents for the 10 species selected for the BWS experiment. The second column of Table 5 shows the simulation results. Based on those results, if respondents were asked to choose the most important specie between the ten species presented to them, 52.75 % would choose the St. Lawrence Estuary beluga. Next, comes the woodland caribou, forest-dwelling ecotype, with 15.26 % of respondents predicted to choose that specie as the most important, and so on.

Evidently, both RIS and preference shares reveal a strong preference among respondents for the St. Lawrence Estuary beluga (24.43 and 52.75 %), followed by the woodland caribou (19.24 and 15.26 %). However, while the RIS of golden eagle ranks third (13.81), it ranks fourth with preference shares (5.99 %) after the rusty patched bumble bee (12.94 %). Thereafter, the order of preference is the same for both measures except for the least preferred two species, for which rankings are inverted when moving from scores to preferences.

Given that the beluga or caribou are not every-one's most preferred species, and that each specie is the favorite of some respondents, it is understood that a larger proportion of the population can be reached if species recovery is promoted as a program that includes several species rather than a single one. Table 6 shows the three most successful portfolios derived from the TURF analysis which included a range of 20 possible portfolios. The portfolios all include the top five importance species in terms of their scores and preferences shares as shown in Table 5. The results are encouraging, as the penetration rate for the three portfolios exceeds 96 %. Moreover, the sixth species could be easily interchanged without compromising the reach percentage.

Following the BWS exercise, we asked respondents why they prefer some species to others; respondents could choose multiple answers. Fig. 3 reports their choices. The reason most often chosen (57 %) was that "they play an important ecological role", followed by "they are very

Table 4
Respondents (n = 880) preferences towards and activities in nature.

	Sample characteristics	Proportion
Likes to spend time in nature	Yes	97 %
	No	3 %
The natural environments visited (% of those who like spending time in nature)	Forests	68 %
	Wetlands	15 %
	Aquatic environments	62 %
	Coastal environments	40 %
	Urban settings (in their neighborhood)	82 %
Frequency of spending time in nature (% of those who like spending time in nature)	Everyday	6 %
	A few times a week	21 %
	About once a week	17 %
	A few times a month	25 %
	Once a month	11 %
	Less than once a month	20 %
	Never	1 %
Activities in nature (% of those who like spending time in nature)	Wildlife observation	44 %
	Hiking	71 %
	Motorized sports	11 %
	Hunting and trapping	6 %
	Fishing	20 %
	Resourcing (meditation, contemplative walking)	70 %
	Gathering wild products	11 %
	Work (wood cutting, maple syrup production, surveying, inventory, etc.)	6 %
	Other	5 %
Wildlife views	I don't like wildlife because wild animals scare or bother me	2 %
	I have very little interest in wildlife because I have no time to think about it	2 %
	I am indifferent to wildlife	18 %
	I am interested in wildlife and enjoy it very much	79 %
Level of concern about the loss of wildlife in Quebec	Extremely concerned	30 %
	Very concerned	35 %
	Moderately concerned	29 %
	Little concerned	5 %
	Not at all concerned	1 %
What the Quebec government should do to protect endangered wildlife	Much less	1 %
	A little less	1 %
	No change	11 %
	A little more	40 %
	Much more	48 %
N		880

Table 5
BWS experiment relative importance scores and share of preference simulations.

Specie	Relative importance scores	Share of preference %
Beluga whale, St. Lawrence Estuary population	24.43	52.75
Woodland caribou, forest-dwelling ecotype	19.24	15.26
Golden eagle	13.81	5.99
Copper Redhorse	10.53	5.86
Rusty patched bumble bee	9.37	12.94
Wood turtle	8.43	2.03
Barrow's goldeneye	7.46	2.02
Western chorus frog	4.07	1.90
Spring salamander	1.62	0.57
Alewife floater	1.04	0.68

vulnerable" at 47 %, "they are emblematic for Quebec" at 38 %, "they are rare" at 32 % and "I read/listened to something about these species and it struck me" at 29 %. This type of information can assist government agencies in program and program communication development.

Fig. 4 presents the results of a group of six questions that asked respondents to indicate the level of importance they attached to certain reasons to protect endangered wildlife species. Focusing only on the "very important" choice, "We need nature" is the most important reason with 70 %, followed by "Nature-health balance" at 67 %, "Social responsibility" at 64 %, and " Future generations " at 60 %. And focusing on the choices of very and rather important, the " Nature-health balance" and "We need nature" are the most important with 91 % choosing these two categories followed by "Social responsibility" at 88 %, and "Future generations" at 85 %. Finally, all the reasons presented attracted at least "fairly important" importance for a majority of respondents, with "Wildlife observation" attracting the least at 53 %. These answers are consistent with the choices made for the previous question.

3.3. DCE results

As shows in Table 7, the species category prioritized by the program is the attribute that most influences respondent option choices (48.04 %), followed by the annual payment (28.68 %), the number of species recovered in 2041 (13.01 %) and the area of intervention (10.27 %). Importance scores sum up to 100 %.

Table 8 shows relative utility value (UV) percentages for each attribute level. These are zero-centered within attributes and percentages within an attribute sum up to zero. A within-attribute level distribution of zero-centered utilities necessarily includes negative values. Negative utility values do not imply a distaste for the level, but rather a lower relative preference for that level.

Large mammals have the highest UV for the species categories prioritized (67.64 %), followed by fish and molluscs (31.02 %), avian fauna (27.31 %) and insects (27.21 %). In contrast, reptiles (−87.56 %), amphibians (−39.13 %) and small mammals (−26.53 %) have lower UVs. DCE analysis results for this attribute are consistent with BWS analysis results.

UVs decline monotonically with the annual payment level, as expected, ranging from −51.37 % for a $200 annual payment to 28.87 % for a $10 annual payment. Moreover, also as expected, UVs increase monotonically with the number of species to be recovered by 2041, ranging from −20.01 % for 25 recovered species to 15.63 % for 100. UV variation for area of intervention is relatively small. Programs targeting the whole of the province garner the greatest UV (15.99 %) followed by programs targeting the respondent's region (2.14 %). Programs targeting either northern or southern Quebec garnered negative UVs (−12.03 % and −6.09 % respectively).

The DCE analysis also reveals a high negative UV for the status quo (−173.96 %), which indicates that as a whole, respondents prefer change (a recovery program) to the status quo. This gives a positive signal to the implementation of this type of program in terms of social acceptability.

3.4. Simulation results

The scenarios used for our simulations are presented in Table 9. As explained in Section 2.5, our scenarios were built from the attribute levels for which respondents obtained the greatest satisfaction during the DCE experiment, as shown in Table 8, namely 100 recovered species with interventions everywhere in Quebec. After having experimented with a number of simulations, we set the initial payment at $12 (rather than at the preferred $10) to maximize the annual payment without increasing the estimated proportion choosing the status quo. The monetary attribute levels for the large mammals' recovery scenario ($12, $25, $50, $100, $150 and $200) were the only attribute level variations between simulations.

Fig. 5 shows the results of the six simulations. When payments are $12 for all the scenarios, we see that the share of preference is highest for large mammals (#4, 38 %), followed by insects (#2, 23 %), status quo (16 %), fish and molluscs (#3, 12 %) and birds (#1, 10 %). As payments for the large mammal's scenario increase, its share of preference continues to exceed the shares of preference for the other four scenarios for

Table 6
TURF analysis penetration rate from BWS experiment.

Portfolio	Subgroup of species						Penetration rate (%)
#1	Beluga whale	Woodland caribou	Rusty patched bumble bee	Copper Redhorse	Golden eagle	Western chorus frog	96.6
#2	Idem	Idem	Idem	Idem	Idem	Woodland turtle	96.5
#3	Idem	Idem	Idem	Idem	Idem	Barrow's goldeneye	96.4

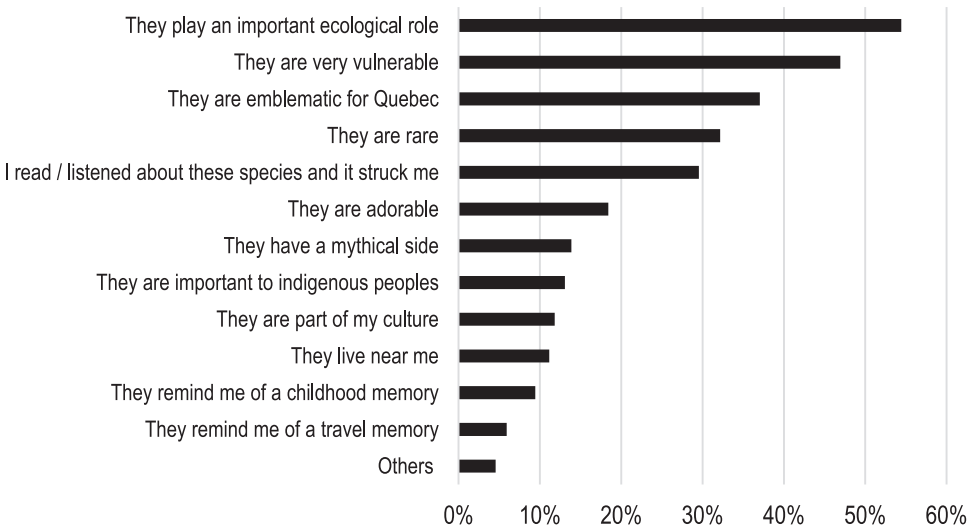


Fig. 3. Reasons why some species are preferred to others.

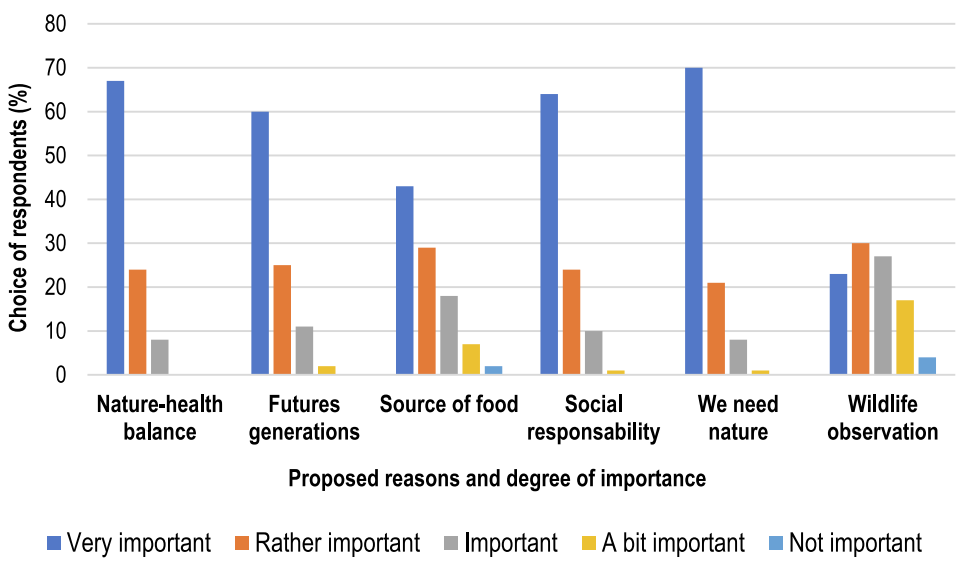


Fig. 4. Level of importance related to certain reasons to protect endangered wildlife species.

Table 7
Relative importance by attribute of an endangered species recovery program.

Attributs	Importance (%)	Std Deviation	Lower 95 % CI	Upper 95 % CI
Number of species recovered in 2041	13.01	8.96	12.42	13.60
Species category prioritized	48.04	14.16	47.11	48.98
Area of intervention	10.27	5.82	9.89	10.66
Annual payment	28.68	14.43	27.72	29.63

the first five payment levels ($12, $25, $50, $100 and $150). Moreover, its preference share does not begin to decline until after its payment increases beyond $50. Its share of preference exceeds that of the other scenarios until its payment reaches $160, at which point the $12 insect scenario (#2) is equally preferred by 25 % of respondents. In other words, at that point, a quarter of respondents are willing to pay 13 times more for a program aimed at the recovery of large fauna than for programs aimed at supporting other categories of species.

Notwithstanding some people's enthusiasm for the recovery of large mammals, payment increases beyond $50 do have an important impact on large mammals' share of preference, which holds steady at 38 % between $12 and $50 payments but declines from 38 % at $50 to 24 % at $200. As the large mammals' scenario payments increase from $12 to

Table 8
Relative utility value (zero-centered) by level of an endangered species recovery program.

Attribute and level	Utility value % (UV)	Std Deviation	Lower 95 % IC	Upper 95 % IC
Number of species recovered in 2041				
100	15.63	23.53	14.08	17.19
75	8.67	13.83	7.75	9.58
50	−4.29	11.49	−5.05	−3.53
25	−20.01	27.02	−21.80	−18.23
Species category prioritized				
Reptiles	−87.56	30.90	−89.60	−85.52
Fish and molluscs	31.02	41.60	28.27	33.77
Birds	27.31	40.72	24.62	30.00
Small mammals	−26.53	41.45	−29.26	−23.79
Amphibians	−39.13	39.96	−41.77	−36.49
Large mammals	67.64	57.68	63.83	71.45
Insects	27.25	62.74	23.10	31.39
Area of intervention				
Southern Quebec	−6.09	11.47	−6.85	−5.34
Northern Quebec	−12.03	14.16	−12.97	−11.10
Everywhere in Quebec	15.99	18.58	14.76	17.22
In my region	2.14	14.45	1.19	3.10
Annual payment				
$10	28.87	45.59	25.86	31.89
$25	21.58	28.72	19.68	23.48
$50	13.39	16.41	12.31	14.47
$100	−12.47	27.81	−14.31	−10.63
$200	−51.37	51.70	−54.79	−47.95
Statut quo option	−173.96	299.94	−193.78	−154.15

Table 9
Species recovery scenarios.

Scenarios	Species category	Annual payment	Number of species recovered by 2041	Intervention area
#1	Birds	$12	100	Everywhere in Quebec
#2	Insects	$12	100	Everywhere in Quebec
#3	Fish and molluscs	$12	100	Everywhere in Quebec
#4	Large mammals	$12, $25, $50, $100, $150, $200	100	Everywhere in Quebec
Status quo	N/A	N/A	N/A	N/A

$200, the birds (#1) share of preference experiences the largest increase, from 10 % to 16 %, a 60 percent increase[2] in the share percentage. Fish and molluscs (#3) have the second highest increase from 12 % to 16 % (a 25 percent increase), followed by the status quo, whose share of preference increases from 16 % to 18 % (a 12 percent increase), and finally, insects (#2), whose share of preference increases from 23 % to 25 % (a 9 percent increase). The increase in the status quo share preference is not large in relation to overall increases in other choices (2 percentage points vs 12 percentage points for recovery scenarios), suggesting that status quo choosers have relatively stable preferences. Respondents' reasons for choosing the status quo are diverse. Their most frequent (provided) reasons for that choice are the government is already taxing us too much (28 %), my financial situation is precarious (24 %), I have other government priorities (21 %) and I have little confidence that the scenarios will be realized (18 %).

[2] While the birds share of preference increased by 6 percentage points, from 10% to 16%, its percentage increase (as opposed to percentage point increase) is a measure of the increase as a proportion of the initial share.

4. Discussion

This study demonstrates a social interest and economic will to support a recovery program for endangered wildlife in Quebec. This result is welcome, as additional funds to finance actions in this direction are needed worldwide (Betts et al., 2020). We discuss below how flagship species can be allies in the promotion of endangered wildlife recovery by combining them with ecosystem services paradigms to increase communication outreach to citizens, and the importance of using broader approaches in developing and supporting endangered wildlife recovery.

4.1. Flagship species as allies to promote endangered wildlife recovery

Our study reveals that the Quebec population is willing to pay much more to protect certain endangered species than others. Results reaffirm the positive influence of flagship species on people's WTP as found by Senzaki, Yamaura, Shoji, Kubo, and Nakamura (2017). Our DCE results simulations reveal that a quarter of respondents are willing to pay 13 times more to recover large mammals than other species categories (insects, fish and molluscs, and birds) at an annual funding level of $12 for other species. Quebec's endangered megafauna could therefore act as a lever to put in place recovery actions that could indirectly benefit other threatened species, as argued by others (Smith, Veríssimo, & MacMillan, 2010; Di Minin & Moilanen, 2014).

Despite this strong preference toward megafauna, our BWS results suggest that a multi-species approach would appeal to all but a few Quebec residents. Topping the list of Quebecer's favorite endangered wildlife species our respondents were presented with are the St. Lawrence Estuary beluga, the woodland caribou (forest ecotype), the rusty-patched bumblebee, the golden eagle and the copper redhorse, which could be considered as Quebec's flagship species. This list does not only contain cute or striking species, but also represents what respondents favor, and may be affected by local and cultural contexts as found in Bowen-Jones and Entwistle (2002). Flagship species provide an opportunity to convey effective conservation messages to the public (Schlagloth, Santamaria, Golding, & Thomson, 2018). However, the incomplete choice of threatened species presented to respondents in our survey is a limitation of the study, which highlights a need to further explore community values and perceptions around threatened species.

This study also reveals the public's openness to provincial and regional recovery programs. This finding could provide Quebec policymakers with conservation policy design flexibility. Notably, the public's favorite species populate diverse natural habitats, including forest, agricultural, aquatic and urban environments, which facilitates interventions in various ecosystems that can benefit many other species (the umbrella effect). Consequently, a flagship multi-species recovery program could both satisfy the preferences of a large majority of the population while preserving a wide range of natural habitats, as was found in Veríssimo, MacMillan, and Smith (2011).

4.2. Combining flagship species and ecosystem services narratives to reinforce conservation outreach to citizens

Respondents in this study revealed a concern about endangered wildlife and an awareness of the human-nature interdependence. In fact, respondents ranked reasons to protect nature that have an ecological significance (such as to keep nature-health balance, because humanity needs nature for its survival or for social responsibility) above reasons related to their own benefits, such as providing food or for wildlife observation. In addition, respondents' most frequent reasons for favoring a species during the BWS experiment, namely their ecological role (57 % of respondents) and vulnerability (47 % of respondents), suggest indicate support the protection of species beyond their charismatic effect or a specific ecosystem service provision. This is consistent with Marvier and Wong (2012)'s findings, where study participants gave

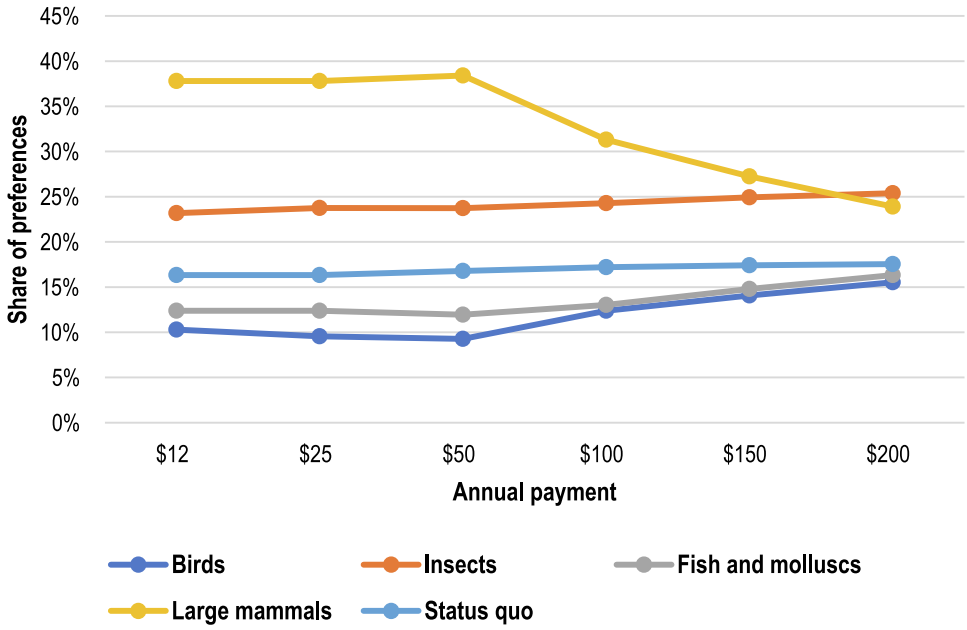


Fig. 5. DCE scenarios simulation results.

equal or greater support to moral reasons than to reasons aimed at meeting human needs as arguments to favor conservation.

However, respondents also enjoy visiting natural environments for a variety of reasons, including resourcing, wildlife observation, and recreational activities. This is good news, as creating connections with nature may increase people's conservation behaviors (Whitburn, Linklater, & Abrahamse, 2020). Although the flagship species approach (which aims to protect the whole specie's habitat) does not have the same purpose as the ecosystem services (ES) approach (which focuses on species that generate benefits for humanity), these two approaches can work in complement and synergy to reinforce conservation efforts (Thompson & Rog, 2019). Based on our results, we believe that a narrative that simultaneously promotes the protection of flagship species and ecosystem services (ES) could successfully harness both the population's interest in nature's services and biodiversity conservation.

In sum, developing an effective communication strategy regarding why and how the government will implement policies to ensure endangered species recovery is a complex task. Kidd et al. (2019) suggest integrating theory (such as the familiarity principle, flagship species or connection to nature) and targeting certain segments of the public to develop effective conservation messages. Although this exploratory research does not alone provide all the elements of an effective threatened species conservation strategy, it offers avenues that could be further explored.

4.3. The blind spot of mobilizing social demand as a lever to protect endangered species

Targeting the endangered species and elements of nature the public cares about can help initiate a conversation with the public on the importance of protecting natural habitats (Jepson & Barua, 2015; Batavia et al., 2018). However, basing conservation policy on public preferences is not a cure-all to biodiversity erosion. Even though flagship species can promote the social acceptability of conservation policies, developing effective conservation priorities requires broader approaches based on ecological evidence (Brambilla, Gustin, & Celada, 2013; Habel, Gossner, & Schmitt, 2021). Ecological criteria such as population viability, habitat vulnerability or endemism should guide policymakers in their prioritization of conservation strategies to allow endangered species to recover.

Indeed, conservation is affected by various networks of interactions, influences and power dynamics, which also are intricately intertwined with other networks with their own *modus operandi* (Meinard, 2017). This complexity hampers the implementation of conservation actions, especially if policymakers are aiming to obtain acceptability from industry and conservation stakeholders. The flagship species that emerged as the Quebec Cinderella species in our two choices experiment are the St. Lawrence Estuary beluga and the woodland caribou (forest ecotype). Even though the public adores these species and is willing to finance their recovery, their protection raises important trade-offs between economic activity and conservation objectives. Nonetheless, the importance of economic activity pales when humanity is confronted with the prospect of widespread and irreversible ecological collapse.

It is important to note that an underlying assumption of our DCE models is that the public's WTP is conditional on the success of the measure as described in the questionnaire and experiment. Scope effects are revealed by the utility values reported in Table 8 in the section on the number of species conserved: utility values are monotonically increasing in the number of species conserved. Many of the species considered in this analysis are threatened by stressors such as urbanisation, commercial navigation, agriculture, and the logging industry, which implies that wildlife recovery policies not only require public support, but also government commitment toward biodiversity conservation.

We believe that conservation organizations can play a key role in conservation policy development, serving as a link with the population, a fundraising and public relations vehicle, and a source of information on the ecological needs of managed lands. Given respondents' marked interest in contributing financially to the protection of endangered wildlife and their heterogeneous preferences, non-for-profit organizations involvement in conservation policy can increase its effectiveness while providing a key intermediary role between citizen demand and the state's capacity for action.

5. Conclusion

While our research has demonstrated a significant public interest in supporting the recovery of endangered species, this will require major investments and the reduction of encroaching economic and other activities threatening their viability. A formidable endangered species recovery program could not only achieve endangered species' recovery,

but also serve as an important lever to improve the ecological health of their host territories and the ecosystem services they provide, such as carbon sequestration, water filtration, and recreation opportunities. The loss of wildlife species reflects the ecological health of our planet, and concrete and sustained policy action to address this loss is necessary for the revitalisation of ecosystems, which not only provide countless benefits for humanity but are necessary for its survival.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: This research was partially funded by Quebec's Ministry of Forest, Wildlife and Parks (MFWP), as part of their project to modernize their wildlife habitats regulation. Our mandate was to analyze social, economic and ecological components associated with the conservation of threatened, vulnerable or susceptible wildlife to assist Quebec decision-makers prioritize endangered wildlife conservation and rehabilitation interventions. The extent of MFWP involvement in the research was as follows: MFWP employees reviewed and commented on the research questionnaire and the discrete choice experiment design (DCE) and participated in the selection of endangered species that would be included in the study (DCE and MaxDiff). The analysis of results and drafting of this work was entirely conducted by the manuscript's authors with no involvement from MFWP employees. Sawtooth Software provided a student grant for the free use of the software and had no involvement in the research design or analysis.

Data availability

Data will be made available on request.

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Appendix A. . Species with status in Quebec, Canada[a]

Threatened species		
Pisces		
Latin name	**Species**	**Espèces**
Moxostoma hubbsi	Copper Redhorse	Chevalier cuivré
Ammocrypta pellucida	Eastern Sand Darter	Dard de sable
Ichthyomyzon fossor	Northern Brook Lamprey	Lamproie du Nord
Amphibians		
Nom latin	**Species**	**Espèce**
Desmognathus ochrophaeus	Northern Dusky Salamander	Salamandre sombre des montagnes
Turtles		
Nom latin	Species	Espèce
Dermochelys coriacea	Leatherback Sea Turtle	Tortue luth
Emydoidea blandingii	Blanding's Turtle	Tortue mouchetée
Sternotherus odoratus	Eastern Musk Turtle	Tortue musquée
Apalone spinifera	Spiny Softshell	Tortue-molle à épines
Birds		
Nom latin	**Species**	**Espèce**
Podiceps auritus	Horned Grebe	Grèbe esclavon
Septophaga cerulea	Cerulean warbler	Paruline azurée
Lanius ludovicianus	Loggerhead Shrike	Pie-grièche migratrice
Melanerpes erythrocephalus	Red-headed Woodpecker	Pic à tête rouge
Charadrius melodus	Piping Plover	Pluvier siffleur
Coturnicops noveboracensis	Yellow Rail	Râle jaune
Sterna caspia	Caspian Tern	Sterne caspienne
Sterna dougallii	Roseate Tern	Sterne de Dougall
Mammals		
Nom latin	**Species**	**Espèce**
Delphinapterus leucas	Beluga Whale - St. Lawrence Estuary Population	Béluga, population de l'estuaire du Saint-Laurent
Gulo gulo	Wolverine	Carcajou
Rangifer tarandus	Woodland Caribou - Atlantic - Gaspésie Population	Caribou des bois, écotype montagnard, population de la Gaspésie
Insects		
Nom latin	**Species**	**Espèce**
Coenonympha nipisiquit	Maritime ringlet	Satyre fauve des Maritimes
Vulnerable species		
Pisces		
Nom latin	**Species**	**Espèce**
Alosa sapidissima	American shad	Alose savoureuse
Moxostoma carinatum	River redhorse	Chevalier de rivière
Osmerus mordax	Rainbow Smelt - St. Lawrence Southern Estuary	Éperlan arc-en-ciel, population du sud de l'estuaire du Saint-Laurent
Percina copelandi	Channel Darter	Fouille-roche gris
Notropis bifrenatus	Bridle Shiner	Méné d'herbe
Amphibians		
Nom latin	**Species**	**Espèce**
Pseudacris triseriata	Western Chorus Frog	Rainette faux-grillon de l'Ouest
Gyrinophilus porphyriticus	Spring Salamander	Salamandre pourpre
Turtles		
Nom latin	**Species**	**Espèce**
Glyptemys insculpta	Wood Turtle	Tortue des bois
Graptemys geographica	Northern Map Turtle	Tortue géographique
Birds		

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Nom latin	Species	Espèce
Aquila chrysaetos	Golden Eagle	Aigle royal
Histrionicus histrionicus	Harlequin Duck - Eastern Population	Arlequin plongeur
Falco peregrinus anatum	Peregrine falcon	Faucon pèlerin anatum
Bucephala islandica	Barrow's Goldeneye - Eastern Population	Garrot d'Islande
Catharus bicknelli	Bicknell's Thrush	Grive de Bicknell
Ixobrychus exilis	Least Bittern	Petit blongios
Haliaeetus leucocephalus	Bald Eagle	Pygargue à tête blanche
Mammals		
Nom latin	**Species**	**Espèce**
Rangifer tarandus	Woodland Caribou - forest-dwelling ecotype	Caribou des bois, écotype forestier
Ursus maritimus	Polar Bear	Ours blanc
Wildlife species likely to be designated as threatened or vulnerable		
Pisces		
Nom latin	**Species**	**Espèce**
Anguilla rostrata	American Eel	Anguille d'Amérique
Ameiurus natalis	Yellow Bullhead	Barbotte jaune
Esox niger	Chain Pickerel	Brochet maillé
Esox americanus vermiculatus	Grass Pickerel	Brochet vermiculé
Brosme brosme	Cusk	Brosme
Myoxocephalus quadricornis	Fourhorn Sculpin	Chaboisseau à quatre cornes
Myoxocephalus thompsonii	Deepwater sculpin	Chabot de profondeur
Noturus flavus	Noturus flavus	Chat-fou des rapides
Noturus insignis	Margined madtom	Chat-fou liséré
Coregonus artedi	Isco	Cisco de printemps
Lepomis peltastes	Northern sunfish	Crapet du Nord
Etheostoma caeruleum	Rainbow darter	Dard arc-en-ciel
Acipenser fulvescens	Lake sturgeon	Esturgeon jaune
Acipenser oxyrinchus	Atlantic sturgeon	Esturgeon noir
Anarhichas denticulatus	Northern wolffish	Loup à tête large
Anarhichas lupus	Atlantic wolffish	Loup atlantique
Anarhichas minor	Spotted wolffish	Loup tacheté
Lamna nasus	Porbeagle	Maraîche
Hybognathus hankinsoni	Brassy minnow	Méné laiton
Gadus morhua	Atlantic cod, maritimes population	Morue franche, population des Maritimes
Gadus morhua	Atlantic cod, Laurentian North population	Morue franche, population nord-laurentienne
Salvelinus alpinus oquassa	Sunapee trout	Omble chevalier oquassa
Leucoraja ocellata	Winter skate	Raie tachetée
Prionace glauca	Blue shark	Requin bleu
Notropis rubellus	Rosyface shiner	Tête rose
Amphibians		
Nom latin	**Species**	**Espèce**
Lithobates palustris	Pickerel Frog	Grenouille des marais
Pseudacris maculata	Boreal chorus frog	Rainette faux-grillon boréale
Hemidactylium scutatum	Four-toed Salamander	Salamandre à quatre orteils
Desmognathus fuscus	Northern dusky salamander	Salamandre sombre du Nord
Snakes		
Nom latin	**Species**	**Espèce**
Diadophis punctatus	Ring-necked snake	Couleuvre à collier
Storeria dekayi	De Kay's brown snake	Couleuvre brune
Nerodia sipedon	Common watersnake	Couleuvre d'eau
Lampropeltis triangulum	Milk snake	Couleuvre tachetée
Thamnophis sauritus	Ribbon snake	Couleuvre mince
Opheodrys vernalis	Smooth Greensnake	Couleuvre verte
Turtles		
Nom latin	**Species**	**Espèce**
Clemmys guttata	Spotted turtle	Tortue ponctuée
Birds		
Nom latin	**Species**	**Espèce**
Calidris canutus rufa	Red Knot	Bécasseau maubèche *rufa*
Ammospiza nelsoni	Nelson's Sparrow	Bruant de Nelson
Ammodramus savannarum	Grasshopper Sparrow	Bruant sauterelle
Tyto alba	Barn owl	Effraie des clochers
Antrostomus vociferus	Eastern whip-poor-will	Engoulevent bois-pourri
Chordeiles minor	Common nighthawk	Engoulevent d'Amérique
Falco peregrinus tundrius	Arctic Peregrine	Faucon pèlerin *tundrius*
Asio flammeus	Short-eared owl	Hibou des marais
Chaetura pelagica	Chimney Swift	Martinet ramoneur
Contopus cooperi	Olive-sided Flycatcher	Moucherolle à côtés olive
Oceanodroma leucorhoa	Leach's Storm-Petrel	Océanite cul-blanc
Vermivora chrysoptera	Golden-winged Warbler	Paruline à ailes dorées
Cardellina canadensis	Canada warbler	Paruline du Canada
Parkesia motacilla	Louisiana Waterthrush	Paruline hochequeue
Euphagus carolinus	Rusty blackbird	Quiscale rouilleux
Cistothorus platensis	Grass wren	Troglodyte à bec court
Mammals		
Nom latin	**Species**	**Espèce**

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Eubalaena glacialis	North Atlantic Right Whale	Baleine noire
Mustela nivalis	Least weasel	Belette pygmée
Delphinapterus leucas	Beluga whale, Eastern Hudson Bay population	Béluga, population de l'est de la baie d'Hudson
Delphinapterus leucas	Beluga whale, Ungava Bay population	Béluga, population de la baie d'Ungava
Microtus chrotorrhinus	Rock vole	Campagnol des rochers
Synaptomys cooperi	Southern bog lemming	Campagnol-lemming de Cooper
Microtus pinetorum	Woodland voles	Campagnol sylvestre
Lasionycteris noctivagans	Silver-haired ba	Chauve-souris argentée
Lasiurus cinereus	Hoary bat	Chauve-souris cendrée
Myotis leibii	Eastern small-footed bat	Chauve-souris pygmée de l'Est
Lasiurus borealis	Eastern red bat	Chauve-souris rousse
Puma concolor	Cougar	Cougar
Phocoena phocoena	Harbour porpoise	Marsouin commun
Odobenus rosmarus	Walruses	Morse
Sorex gaspensis	Gaspé Shrew	Musaraigne de Gaspé
Sorex dispar	Long-tailed shrew	Musaraigne longicaude
Glaucomys volans	Southern flying squirrel	Petit polatouche
Phoca vitulina mellonae	Ungava Seal	Phoque commun des lacs des Loups Marins
Perimyotis subflavus	Tricolored bat	Pipistrelle de l'Est
Balaenoptera musculus	Blue whale	Rorqual bleu
Balaenoptera physalus	Fin whale	Rorqual commun
Bivalves		
Nom latin	**Species**	**Espèce**
Alasmidonta marginata	Elktoe	Alasmidonte rugueuse
Utterbackiana implicata	Alewife Floater	Anodonte du gaspareau
Elliptio crassidens	Elephant-ear	Elliptio à dents fortes
Eurynia dilatata	Spike mussel	Elliptio pointu
Leptodea fragilis	Fragile Papershell	Leptodée fragile
Margaritifera margaritifera	Freshwater pearl mussel	Mulette-perlière de l'Est
Obovaria olivaria	Olive Hickorynut	Obovarie olivâtre
Potamilus alatus	Pink heelsplitter	Potamile ailé
Gastropods		
Nom latin	**Species**	**Espèce**
Acroloxus coloradensis	Rocky Mountain capshell	Patelle d'eau douce pointue
Birgella subglobosus	Globe siltsnail	Somatogyre globuleux
Insects		
Nom latin	**Species**	**Espèce**
Acronicta rubricoma	Ruddy Dagger Moth	Acronicte à virgules rougeâtres
Nasiaeschna pentacantha	Cyrano Darner	Aeschne Cyrano
Gomphaeschna furcillata	Harlequin Darner	Aeschne pygmée
Bombus affinis	Rusty-patched bumble bee	Bourdon à tache rousse
Bombus terricola	Yellow-banded bumblebee	Bourdon terricole
Cicindela lepida	Ghost tiger beetle	Cicindèle blanche
Cicindela patruela	Northern barrens tiger beetle	Cicindèle verte des pinèdes (=Cincidèle verte à lunules)
Adalia bipunctata	Two-spot ladybird	Coccinelle à deux points
Coccinella novemnotata	Nine-spotted ladybug	Coccinelle à neuf points
Williamsonia fletcheri	Ebony boghaunter	Cordulie bistrée
Somatochlora incurvata	Incurvate emerald	Cordulie incurvée
Lycaena dospassosi	Maritime copper	Cuivré des marais salés
Dolichoderus mariae	*Dolichoderus mariae*	*Dolichoderus mariae*
Xyloryctes jamaicensis	Rhinoceros beetle	Dynaste rhinocéros
Erythemis simplicicollis	Eastern pondhawk	Érythème des étangs
Erythrodiplax berenice	Seaside Dragonlet	Érythrodiplax côtier
Cephaloon ungulare	False longhorned beetle	Faux-longicorne scalaire
Adela caeruleella	Southern longhorn moth	Fée noire aux longues antennes
Euptoieta claudia	Variegated Fritillary	Fritillaire panachée
Gomphus ventricosus	Skillet Clubtail	Gomphe ventru
Pompeius verna	Little Glassywing	Hespérie à taches vitreuses
Euphyes dion	Dion skipper	Hespérie de Dioné
Erynnis martialis	Mottled duskywing	Hespérie tachetée
Lasius minutus	*Lasius minutus*	*Lasius minutus*
Lestes vigilax	Swamp spreadwing	Leste matinal
Melanoplus gaspesiensis	Gaspésie Grasshopper	Mélanople de Gaspésie
Oeneis bore gaspeensis	White-veined Arctic	Nordique à nervures blanches de Gaspé
Ophiogomphus anomalus	Extra-striped snaketail	Ophiogomphe bariolé
Phymatodes maculicollis	Longhorned Beetle	Phymatode à col maculé
Neospondylis upiformis	Onghorned beetle	Spondyle ténébrion
Sympetrum corruptum	Variegated meadowhawk	Sympétrum bagarreur
Trechus crassiscapus	Trechus	Tréchine à scapes larges

[a] Retrieved (2022-05-18) from: https://mffp.gouv.qc.ca/la-faune/especes/especes-menacees-vulnerables/.

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