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LETTER

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Prioritizing recovery funding to maximize conservation of endangered species

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Abstract

The absence of a rigorous mechanism for prioritizing investment in endangered species management is a major implementation hurdle affecting recovery. Here, we present a method for prioritizing strategies for endangered species management based on the likelihood of achieving species' recovery goals per dollar invested. We demonstrate our approach for 15 species listed under Canada's Species at Risk Act that co-occur in Southwestern Saskatchewan. Without management, only two species have >50% probability of meeting recovery objectives; whereas, with management, 13 species exceed the >50% threshold with the implementation of just five complementary strategies at a cost of $126m over 20 years. The likelihood of meeting recovery objectives rarely exceeded 70% and two species failed to reach the >50% threshold. Our findings underscore the need to consider the cost, benefit, and feasibility of management strategies when developing recovery plans in order to prioritize implementation in a timely and cost-effective manner.

KEYWORDS

complementarity, cost-effectiveness, critical habitat, expert elicitation, multiobjective optimization, multispecies conservation, Priority Threat Management, priority-setting, recovery planning, SARA, Saskatchewan, South of the Divide, species at risk, structured decision making, triage

1 | INTRODUCTION

Rarely do agencies charged with the recovery of endangered species have sufficient funds to implement recovery plans in their entirety. More often, they must choose which management strategies to implement over others, with incomplete knowledge of which strategies will be most effective at achieving species recovery goals. This problem becomes even more acute when implementing recovery plans for multiple endangered species simultaneously (Lundquist, Diehl, Harvey, & Botsford, 2002) or when political pressure to recover iconic species is high (Hebblewhite, 2017). The lack of a rigorous and repeatable way to make these choices has led to, at best, delays in species recovery plan implementation and, at worst, species extinction (Martin, Nally et al., 2012). In a recent review of the U.S. Endangered Species Act, the establishment and consistent application of a system for prioritizing recovery funding to maximize strategic outcomes for listed species was the single most important issue identified to increase the effectiveness of implementation (Evans, Che-Castaldo, & Crouse, 2016). In this article, we present a method for doing exactly that—prioritizing management strategies for endangered species based on their likelihood of achieving species recovery goals per dollar invested.

Priority Threat Management (PTM) is a participatory process that helps decision-makers decide which management strategies to invest in to recover as many species as possible per dollar invested, by defining and comparing the cost-effectiveness of strategies for mitigating threats to species and ecosystems (Carwardine, Martin, & Firn, 2018). Cost-effectiveness is an economic tool increasingly used in conservation (Brazill-Boast et al., 2018; Carwardine et al., 2012; Joseph, Maloney, & Possingham, 2009) and natural resource management (Pannell et al., 2012) to inform investment decisions by evaluating the costs of achieving a noneconomic benefit (Levin & McEwan, 2001), in this case the recovery of endangered species. PTM has been applied to address a range of threats to the persistence of native plants, animals, and ecosystems of conservation concern (Carwardine et al., 2012; Chadès, Nicol, & van Leeuwen, 2015; Firn, Maggini et al., 2015; Firn, Martin et al., 2015; Ponce Reyes, Firn, & Nicol, 2016). Our study is the first application of this approach to endangered species in Canada, where recovery objectives vary across species. PTM harnesses scientific and expert-derived information to appraise management strategies based on their financial cost and feasibility, and their benefits to species and ecosystem conservation. By applying this approach to endangered species recovery, we can answer key questions such as: how much will it cost to recover all endangered species; which management strategies are likely to achieve the greatest recovery of species per dollar invested; how many species can we recover for a given budget; and which species are unlikely to be recovered regardless of investment?

When applied to endangered species, PTM offers a rigorous and repeatable means of prioritizing conservation strategies and has the potential to improve the efficiency of recovery implementation around the globe. Here, we demonstrate this utility by prioritizing the implementation of recovery strategies listed in the "Action Plan for Multiple Species at Risk in Southwestern Saskatchewan: South of the Divide" (herein called Action Plan, Environment and Climate Change Canada, 2017).

2 | METHODS

2.1 | Case study

The Action Plan addresses the recovery of 13 species listed under Canada's Species at Risk Act and co-occurring in the South of the Divide (SoD): an area of over 1,415,700 ha, half of which contains remnant native mixed-grass prairie (Figure S1). Less than 30% of Canada's temperate grasslands remain intact (Federal Provincial and Territorial Governments of Canada, 2010) and as a result, many of the species associated with grassland habitats are under threat. Within the Action Plan, nine species are listed as either extirpated, endangered, or threatened (black-footed ferret, burrowing owl, eastern yellow-bellied racer, greater sage-grouse, prairie loggerhead shrike, mormon metalmark, mountain plover, Sprague's pipit, swift fox) and four species are listed as special concern (black-tailed prairie dog, long-billed curlew, McCown's longspur, and northern leopard frog). We also included two additional threatened species-ferruginous hawk and chestnut-collared longspur, which co-occur in the study area, bringing the total number of species included in this analysis to 15 (Table S1 for species scientific names and Figure S1 for study area).

2.2 | Data collection

We collated existing information on the distribution and habitat use of the 15 species along with the proposed management strategies and underlying actions that were outlined in the Action Plan (Environment and Climate Change Canada, 2017; Table S2). For the PTM analysis, we consider "strategies" as a collection of discrete actions that, if implemented, would feasibly reduce the impact of one or more of the threats. These strategies may rely on research or new technology, but they have the constraint that experts must be able to reliably quantify the benefits to species recovery of the strategies if implemented. We worked with a core team of contributors responsible for the development of the Action Plan to organise the actions within the plan to ensure that strategies were distinct from one another and included actions for which costs, benefits, and feasibility could be estimated. We did not assign any new actions to species beyond those stated in the Action Plan. We defined benefit as the improved probability of achieving a species' population and distribution objectives, given the successful implementation of a management strategy within the SoD (Table S1).

We elicited information about the costs, benefits, and feasibility of management strategies, required for the PTM analysis from experts through an intensive 3-day workshop and follow-up consultations, using a modified Delphi structured elicitation approach outlined in Carwardine et al. (2018) and Hemming, Burgman, Hanea, McBride, and Wintle (2018) (see Methods S1). Nine experts in the ecology and management of the SoD region from Government agencies and Universities, many of whom were contributors to the development of the Action Plan, participated in this workshop and subsequent follow-up conversations.

We identified 14 management strategies composed of 47 underlying actions for evaluation at the start of the workshop (Table 1, Table S2). In addition, four combinations of strategies were evaluated (Table 1, Table S2), due to their synergistic nature generating benefits greater than that of the component strategies. When collected and analysed appropriately, expert-elicited information has been shown to be a cost-effective and efficient way of capturing the responses of wildlife populations to management interventions (Hemming et al., 2018; Martin, Burgman et al., 2012).

Experts estimated the potential benefits, costs, and feasibility of implementing each strategy over a 20-year period. This time frame was chosen because it encompassed multiple generation times for the species considered in the analysis and is therefore a reasonable duration over which recovery success could be expected, and was within the realm of experience of the experts.

2.3 | PTM analysis

The analysis involved five steps:

1. *Quantifying the total costs of each management strategy*: Pairs of experts estimated the monetary cost of each management strategy (see Methods S2 for details, Table 1).
2. *Measuring the feasibility of each management strategy*: The feasibility of a strategy was estimated by the same expert pair that calculated the cost of the strategy (see Methods S3 for details, Table 1).
3. *Establishing the benefits of each management strategy*: The benefit of each strategy to the recovery of a particular species was estimated by each expert individually (see Methods S4 for details, Table 1). We used a four point elicitation procedure (Martin, Burgman et al., 2012; Speirs-Bridge et al., 2010), which comprises a best guess, and an estimate of the upper and lower bounds, along with an assessment of the confidence that the true value lies within these bounds. The potential benefit B_i of implementing a strategy was defined as the total difference in the probability of achieving species population and distribution objectives as stated in their respective National Recovery Strategies with and without implementation of that strategy. Where needed, objectives were rescaled to reflect what was considered possible in the study region (Table S1). Benefit estimates for each species were elicited from each expert independently and then averaged to produce a single estimate for each species and strategy:

$$B_i = \sum_{j=1}^{N} \frac{\sum_{k=1}^{M_j} \left(P_{ijk} - P_{0jk}\right)}{M_j} \quad (1)$$

Where, P_{ijk} is the probability of achieving species population and distribution objectives for species j if strategy i is implemented, estimated by expert k. P_{0jk} is the probability of achieving the species population and distribution objective for species j if no strategy is implemented (baseline scenario), estimated by the same expert k. N is the number of species; and M_j is the number of experts who made predictions for species j.

4. *Run prioritization scenarios*: Strategies were prioritized in two ways. First by ranking independently according to cost-effectiveness and second, by selecting complementary sets of strategies that optimize the expected benefit for a given budget. Using the first method, the strategy that provides the highest benefit-to-cost ratio, is ranked highest (Levin & McEwan, 2001). The cost-effectiveness of each strategy i (CE_i) is calculated as the potential benefit of the strategy (B_i) multiplied by feasibility (F_i) divided by the expected cost (C_i):

$$CE_i = \frac{B_i F_i}{C_i} \quad (2)$$

Budgetary constraints often prevent implementing all threat management strategies at once. In this case, we want to identify optimal sets of strategies that achieve target levels of recovery success (>50%, >60%, >70%) for as many species as possible at minimal cost, which forms a multi-objective problem (Figueira, Greco, Mousseau, & Słowiński, 2008). Thus we undertook a second prioritization using a complementarity analysis, where solutions are a trade-off between the objectives of maximizing recovery success and minimizing the cost (Chadès et al., 2015; Methods S5).

5. *Conduct uncertainty analyses*: We conducted a sensitivity analysis to assess how expert uncertainty in the benefit estimates may change priority rankings of the strategies by comparing priorities based on experts' best

TABLE 1 Cost-effective appraisal of conservation management strategies to achieve recovery targets for 15 listed species in the SoD region of Southern Saskatchewan

Strat. no.	Management[a] strategy	CE rank	CE score = (B * F)/C	Uptake	Success	Feasibility (F = uptake * success)	Benefit[b] (B)	Rank benefit	Rank expected benefit (B * F)	Cost (C)[c] over 20 years	Annual equivalent value
S8	Management of linear development and infrastructure	1	6.48	0.76	0.68	0.51	57	9	9	$454,594	$33,450
S4	Headstarting	2	3.45	0.95	0.6	0.57	26	14	12	$436,044	$32,085
S13	Regulation and policy	3	2.24	0.76	0.94	0.71	63	8	8	$2,000,783	$147,221
S7	Integrated pest management	4	1.77	0.5	1	0.5	48	10	10	$1,359,033	$100,000
S14	Habitat conservation	5	0.7	0.89	0.75	0.66	220	5	6	$20,754,453	$1,527,149
S12	Fire management	6	0.7	1	0.5	0.5	21	16	14	$1,533,992	$112,874
S5	Disease management	7	0.63	0.92	0.36	0.33	43	11	13	$2,255,357	$165,953
S15	Land stew (S9) + hab cons (S14)	8	0.47	0.88	0.85	0.75	411	4	4	$64,861,583	$4,772,629
S2	Predator exclusion	9	0.4	0.95	0.74	0.71	32	12	11	$5,751,076	$423,174
S9	Land stewardship (results & practice)	10	0.34	0.88	0.95	0.83	179	6	5	$44,107,131	$3,245,480
S17	Infra (S8) + land stew (S9) + hab rest (S10) + Hab cons (S14)	11	0.29	0.83	0.79	0.66	525	3	2	$121,142,321	$8,913,864
S6	Beneficial management practices for farmland	12	0.28	1	0.48	0.48	22	15	15	$3,747,220	$275,727
S16	Pop aug (S3) + infra (S8) + land stew (S9) + hab rest (S10) + hab cons (S14)	13	0.25	0.75	0.77	0.58	542	2	3	$125,784,350	$9,255,433
S18	All strategies combined	14	0.24	0.79	0.62	0.48	708	1	1	$143,951,234	$10,592,184
S1	Species reintroduction	15	0.2	0.5	0.05	0.03	29	13	18	$359,696	$26,467
S11	Exotic species management	16	0.19	0.67	0.12	0.08	18	17	17	$723,683	$53,250
S3	Population augmentation	17	0.1	0.43	0.68	0.29	16	18	16	$4,642,029	$341,569
S10	Habitat restoration	18	0.09	0.8	0.8	0.64	79	7	7	$55,826,143	$4,107,785

[a]Management strategies are made up of multiple actions—see Table S2 for individual action that make up each strategy.

[b]When estimating the benefits of strategies, it was assumed that management strategies identified by the adjacent Grasslands National Park in their own action plan would be implemented and ongoing in the park in order to secure the persistence of species within the park. For example, movement of greater sage-grouse from Grasslands National Park into the SoD area will contribute to the likelihood of meeting recovery objectives for greater sage-grouse within the SoD.

[c]Cost is the present value over 20 years, discounted at 4%.

guess with priorities based on their upper and lower bounds (see Methods S6 for details).

3 | RESULTS

The estimated cost of undertaking all of the 14 individual strategies was $144m over 20 years or $10.6m annually (Table 1). The five most cost-effective individual strategies in priority were: Management of Linear Development and Infrastructure, Headstarting, Regulation and Policy, Integrated Pest Management and Habitat Conservation (refer to Table S2 for definitions of strategies) at a total cost of $25m over 20 years or $1.8m annually (Table 1). Three of these strategies (Management of Linear development and Infrastructure, Regulation and Policy, Integrated Pest Management) had moderate benefits and very low cost, whereas Habitat Conservation had a very high expected benefit that offset the moderately high cost ($20.7m or $1.5m annually over 20 years; Table 1).

The two least cost-effective individual strategies were Habitat Restoration and Population Augmentation. Despite having a relatively high expected benefit (benefit * feasibility), Habitat Restoration was the most costly individual strategy (estimated at $364 per ha, or $4.1m annually) and ranked low in terms of cost-effectiveness. Population Augmentation only applied to one species, the greater sage-grouse, and therefore had a low benefit with a relatively high cost (Table 1). However, when Population Augmentation was combined with Management of Linear Development and Infrastructure, Habitat Conservation, Land Stewardship and Habitat Restoration, this combined strategy (Strategy 17, Table 1) was the only strategy that allowed greater sage-grouse to achieve a >50% probability of meeting its recovery objective.

Under the current baseline scenario (no management; see baseline Table 2, Table S3) 13 of the 15 species are expected to have a less than 50% probability of meeting recovery objectives (range 0-73%, average 33%). Only two species, eastern yellow-bellied racer and mormon metalmark are expected to have a >50% likelihood (63% and 73%, respectively) of meeting recovery objectives without additional management. Our complementarity analysis found that an investment of $65m over 20 years in Habitat Conservation and Habitat Restoration would result in 11 of 15 species meeting the >50% recovery success threshold (Table 2, Figure 1). Doubling this investment to $126m, results in two additional species (greater sage-grouse and swift fox) meeting the >50% recovery success threshold (average 55%, Table 2), with the implementation of five management strategies (Table 2, Figure 1). For two species (black-footed ferret and burrowing owl), the proposed management strategies are insufficient to achieve the >50% threshold probability of meeting their recovery objectives in the next 20 years, with success probabilities of 21% and 37%, respectively (an improvement of 21% and 33% over the baseline scenario; Table 2).

At the >60% threshold of recovery success, eight species are expected to meet the threshold when undertaking all strategies at an annual cost of $10.6m (Figure 1, Table 2). Only three species, the mormon metalmark, eastern yellow-bellied racer, and long-billed curlew, achieved >70% probability of meeting recovery objectives (Figure 1, Table 2). All three species had comparatively conservative recovery objectives of maintaining current abundance or distribution (Table S1).

Species Reintroduction and Headstarting benefitted single species—the black-footed ferret and burrowing owl, respectively. Neither strategy however had a sufficient expected benefit to achieve a >50% likelihood of meeting recovery objectives for these species on their own or in combination with other strategies (Table S3), even though Headstarting ranked second with respect to cost-effectiveness (Table 1). This underscores the importance of examining both cost-effectiveness along with probabilities of meeting recovery thresholds (Table 2, Table S3).

We examined the utility of the PTM approach by comparing the number of additional species that would exceed the 50% recovery success threshold under different investment approaches (Table 2, Figure 2). We find that under all budgets, the PTM approach results in more species recovered per dollar invested than investment decisions based on "random" allocation, "threat status," and "cost" and outperforms decisions based on "benefit" across three of the five budgets (Figure 2).

The sensitivity analysis revealed that the priority order of the strategies was robust to uncertainty in the experts' benefit estimates (see Methods S6 for details). The key change was in the number of species exceeding thresholds of recovery (Table S4).

4 | DISCUSSION

Alarm has been raised that the recovery of endangered species is failing in large part due to the lack of a transparent and systematic approach for prioritizing limited funds (Evans et al., 2016). Part of the challenge of implementation is deciding how to prioritize management strategies given the inevitably limited nature of financial resources for recovery. Without a rational way of making these decisions, funds are often directed toward the most at risk species, often with the lowest likelihoods of recovery, and high costs (Evans et al., 2016; Gerber, 2016; Hebblewhite, 2017). We show here, that we can make limited resources for endangered species go much further by prioritizing investment in management strategies that recover the greatest number of species for the least cost (Figures 1 and 2).

TABLE 2 Results of complementarity analysis (Pareto optimal solutions) showing the probability ((benefit * feasibility) + baseline) of reaching recovery targets (50%, 60%, and 70%). For example, values >50% means the species has a greater than 50% probability of meeting the recovery objective (Table S1). The solutions provide the best strategies to implement, maximizing the number of species secured for the minimum cost. tValues in bold exceed the threshold

Threshold for species recovery		**50%**						**60%**			**70%**	
Budget over 20 years ($m)	0	2.3	20.8	44.1	64.9	121.1	125.8	64.9	121.1	144	20.8	121.1
Budget annually ($m)	0	0.17	1.5	3.2	4.8	8.9	9.3	4.8	8.9	10.6	1.5	8.9
Strategy no.		**S5**	**S14**	**S9**	**S15**	**S17**	**S16**	**S15**	**S17**	**S18**	**S14**	**S17**
Strategies	**Baseline**									**All Strategies**		
Black-footed Ferret	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.9	0.0	0.0
Burrowing Owl	4.4	4.4	16.4	21.5	33.4	37.3	34.0	33.4	37.3	32.2	16.4	37.3
Eastern Yellow-bellied Racer	**62.5**	**62.5**	**73.6**	**68.7**	**80.6**	**86.7**	**83.7**	**80.6**	**86.7**	**80.3**	**73.6**	**86.7**
Greater Sage-grouse	3.1	4.7	23.9	22.9	44.3	46.0	**50.5**	44.3	46.0	42.4	23.9	46.0
Prairie Loggerhead Shrike	35.6	35.9	44.7	48.3	**57.3**	**63.4**	**60.0**	57.3	**63.4**	**60.3**	44.7	63.4
Mormon Metalmark	**72.5**	**72.5**	**79.1**	**76.7**	**80.0**	**79.1**	**78.3**	**80.0**	**79.1**	**79.2**	**79.1**	**79.1**
Mountain Plover	41.7	41.7	47.7	44.4	**51.0**	**50.5**	**50.5**	51.0	50.5	49.8	47.7	50.5
Sprague's Pipit	36.3	36.3	47.3	**51.1**	**62.1**	**66.9**	**63.1**	**62.1**	**66.9**	**61.7**	47.3	66.9
Swift Fox	30.0	31.0	34.3	34.8	39.2	**50.5**	**50.5**	39.2	50.5	47.7	34.3	50.5
Black-tailed Prairie Dog	43.1	**50.1**	**53.1**	**53.0**	**63.2**	**60.8**	**58.7**	**63.2**	**60.8**	**67.5**	53.1	60.8
Long-billed Curlew	41.3	41.3	**51.6**	**53.2**	**63.7**	**71.7**	**68.0**	**63.7**	**71.7**	**68.3**	51.6	**71.7**
McCown's Longspur	29.3	29.3	42.4	43.3	**56.6**	**57.4**	**54.0**	56.6	57.4	55.7	42.4	57.4
Northern Leopard Frog	35.0	37.3	46.1	45.4	**56.8**	**57.5**	**54.7**	56.8	57.5	**61.2**	46.1	57.5
Chestnut-collared Longspur	28.6	28.6	41.6	42.6	**55.9**	**57.2**	**53.6**	55.9	57.2	54.5	41.6	57.2
Ferruginous Hawk	33.8	33.8	46.6	47.3	**60.4**	**65.2**	**61.3**	**60.4**	**65.2**	**60.8**	46.6	65.2
Mean	33.1	33.9	43.2	43.5	53.6	56.7	54.7	56.6	56.6	56.2	43.2	56.6
Number of species above threshold	2	3	4	5	11	12	13	6	7	8	2	3

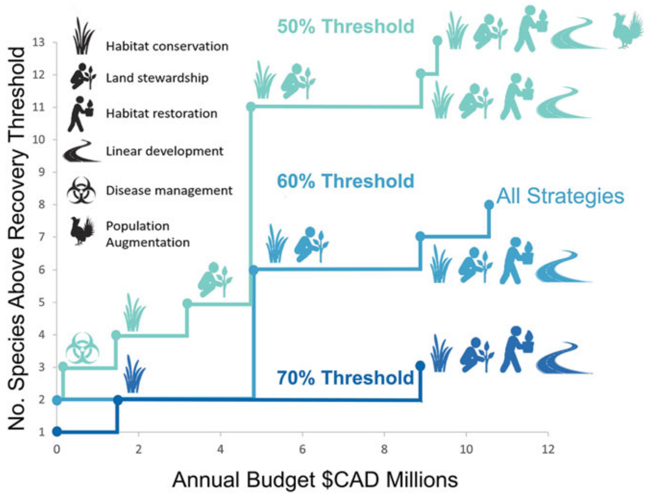

FIGURE 1 The optimal strategy(s) to take to maximize species recovery for a given budget shown for three recovery success thresholds 50%, 60% and 70%. With an investment of \$8.9M annually in Habitat Conservation, Habitat Stewardship, Habitat Protection and Management of Linear Infrastructure and Development, there is >50% probability of recovery success for 12 species, >60% probability of recovery success for 7 species and >70% recovery success for 3 species. With the addition of Population Augmentation, 13 species have >50% probability of recovery success for an investment of \$9.3M annually. See Table 2 for list of species meeting each recovery threshold

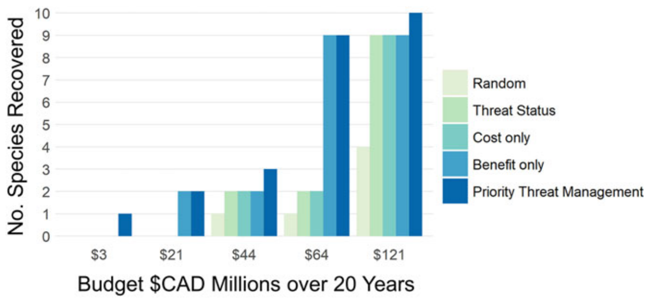

FIGURE 2 Comparison of the number of additional species exceeding the >50% recovery success threshold with alternative investment options under increasing budgets. Random – management strategies are chosen at random; Threat Status – strategies for most at risk species (BFFE, GSGR, BOUW, MOPL) chosen in priority; Cost only – strategies selected from least to most expensive; Benefit only – strategies selected from highest to lowest benefit to species recovery; Priority Threat Management – strategies selected on cost-effectiveness and complementarity

Individually, Habitat Conservation and Land Stewardship have the greatest benefits in the Action Plan at a cost of \$4.8m year (\$65m over 20 years, Figure 1, Table 1). When combined (Strategy 15), their benefits are greater than either strategy individually, indicating a clear priority for investment (Figure 1, Table 2). This combined strategy is concerned with the protection, restoration, and stewardship of "Critical" and "Important" habitat on crown land and private land. The importance of these strategies reflects the uncertainty around land ownership across the region over the next 20 years and in particular the risk of conversion of land from grassland to cropland and oil and gas development.

Our finding that recovery probabilities exceeding 60% or 70% are difficult to achieve for many species even if all management strategies are undertaken is likely driven by three factors. First, the majority of the global distribution of all 15 species lies outside of the SoD. For example, 9 of the 15 species are migratory birds and spend only a portion of their annual cycle in the SoD, but key threats such as habitat loss occur outside of this region (e.g., Pool, Panjabi, & Macías-Duerte, 2014). Had we assumed that simultaneous actions were being undertaken by other jurisdictions responsible for the management of those same species elsewhere within their range (Runge, Martin, Possingham, Willis, & Fuller, 2014), the recovery probabilities would have been markedly higher and species such as the burrowing owl are likely to have exceeded the 50% recovery threshold. Second, low recovery success probabilities may be an indication of research needs. A clearer understanding of the factors limiting populations and how to address them can allow for more effective management interventions. When the proposed management strategies yield only modest benefits, this can signal the need for management strategies that address other limiting factors. Research can play a crucial role in setting recovery objectives that fulfill the intent of endangered species conservation, and feasible conservation actions to achieve these objectives. Finally, objectives might be difficult to achieve because pervasive and widespread environmental changes caused by human activities (e.g., changing weather events) represent serious challenges to species recovery.

In cases where all feasible management strategies have been identified and the benefits of management are still insufficient for >50% probability of meeting recovery objectives, then objectives may need to be modified to reflect less ambitious targets. For example, preventing further decline, while new recovery strategies, including new technologies, are developed or habitat restoration efforts reach a seral stage that can support population growth. In this way, PTM can highlight where additional research could increase the feasibility of strategies and ultimately their cost-effectiveness. In other cases, triage; abandoning management in order to focus resources on other species or subpopulations with a higher likelihood of recovery, may be the most pragmatic decision (Bottrill, Joseph, & Carwardine, 2008).

5 | CONCLUSION

The PTM approach provides valuable documentation of expected benefits and costs, establishes critical baselines for measuring future conservation success, and guides future research by identifying critical uncertainties. Moreover, the approach can motivate action when debates about uncertainty and resource constraints hamper progress toward implementation (Martin, Camaclang, Possingham, Maguire, & Chadès, 2017). Compared to traditional recovery planning, this approach is an order of magnitude lower in cost and shorter in time span (total cost of a PTM assessment ranges from $CDN 200,000 to $CDN 500,000 and takes 6 months to 2 years to complete). The approach presented here illustrates the return on investment for species recovery and in doing so provides a blueprint for informing timely implementation of endangered species recovery action.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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