TRANSFORMING OUR APPROACH TO SPECIES AT RISK:

PRIORITIZING ACTIONS FOR RECOVERY IN THE WOLASTOQ/SAINT JOHN RIVER WATERSHED

This WWF-Canada report could not have been developed without the expertise, analytical skills and contributions of several individuals.

Dr. Abbey Camaclang and Dr. Tara G Martin of the University of British Columbia led the data collection and analysis with support from Jessica Currie, Emily Giles, Simon J. Mitchell and James Snider of WWF-Canada.

Special thanks for the expertise and participation of: Sue Abbott, John Bagnall, Sean Blaney, Connie Browne, Arielle DeMerchant, Rebecca Dolson, Aaron Dowding, Chris Edge, Graham Forbes, Heather Loomer, Deana McCullum, Julie McKnight, Donnie McPhee, Terry Melanson, Pierre Mezzetta, Wendy Monk, Joe Nocera, Zoe O'Malley, Mary Sabine, Adam Samms, Graeme Stewart-Robertson, Kathy St-Laurent, Dakota Tomah, Laura Tranquilla, Martin Williams and one contributor who have requested to remain anonymous.

WWF-Canada. 2020. Transforming our approach to species at risk: Prioritizing actions for recovery in the Saint John River watershed. Prepared by Currie J. Giles E. Mitchell SJ. Snider J. Camaclang A. Martin TG. *World Wildlife Fund Canada*. Toronto, Canada.

WWF-Canada

4th Floor, 410 Adelaide Street West
Toronto, Ontario M5V 1S8

This project was generously supported by the Patrick and Barbara Keenan Foundation and by Fisheries and Oceans Canada through the Canada Nature Fund for Aquatic Species at Risk.

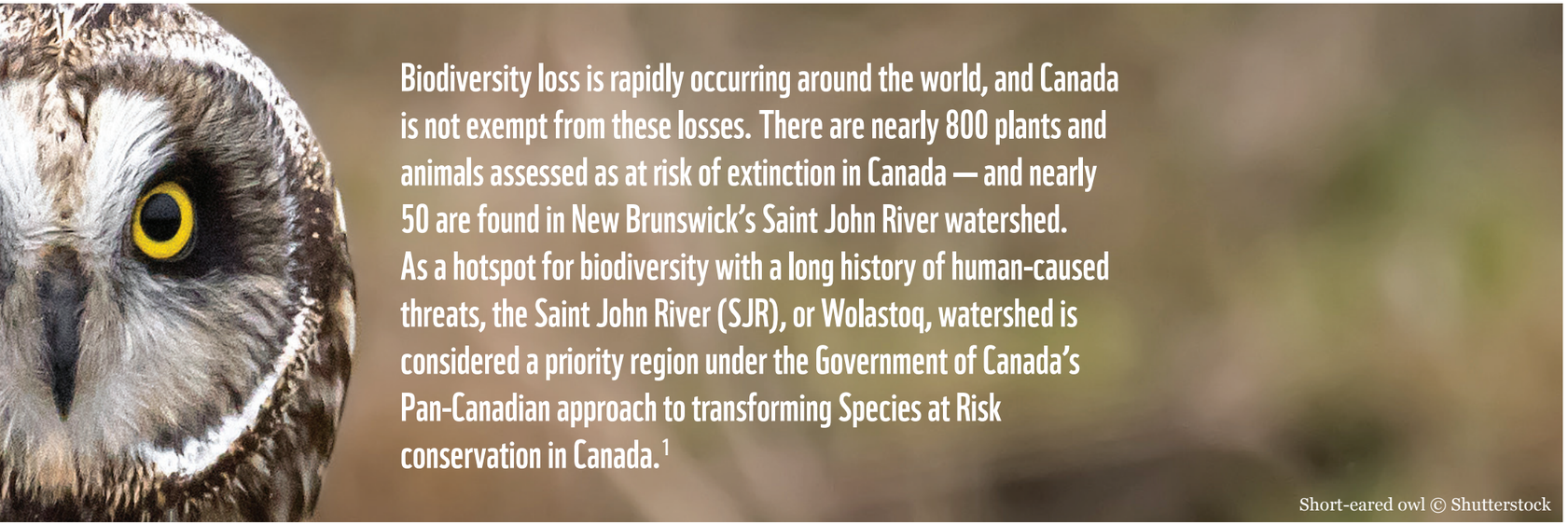
Patrick and Barbara Keenan Foundation

Fisheries and Oceans Canada Pêches et Océans Canada

Rusty blackbird © Shutterstock
Cover photo: Bobolink © Shutterstock

TABLE OF CONTENTS

Executive Summary



Biodiversity loss is rapidly occurring around the world, and Canada is not exempt from these losses. There are nearly 800 plants and animals assessed as at risk of extinction in Canada — and nearly 50 are found in New Brunswick's Saint John River watershed. As a hotspot for biodiversity with a long history of human-caused threats, the Saint John River (SJR), or Wolastoq, watershed is considered a priority region under the Government of Canada's Pan-Canadian approach to transforming Species at Risk conservation in Canada.[1]

Short-eared owl © Shutterstock

As the number of species at risk of extinction continues to grow, it is imperative that we act quickly to manage threats to biodiversity and implement recovery actions to safeguard ecosystems over the long term. Priority Threat Management (PTM) is an emerging decision support framework that facilitates the rapid identification of effective strategies, taking into consideration the costs, benefits and feasibilities of conservation action to maximize the return on investment.

The PTM process was completed in the Wolastoq/SJR watershed from 2019–2020 for 45 species and one forest community group. The species and forest community were categorized into nine ecological groups, with each ecological group expected to have a similar response to threats and management actions. Under the "business-as-usual" scenario, experts estimate that none of the nine ecological groups will have a ≥60 per cent chance of persistence in the Wolastoq/SJR watershed in the next 25 years. This highlights that the current investment of time, capacity and financial resources are likely insufficient to effectively recover species at risk in the watershed.

Under the "business-as-usual" scenario, experts estimate that none of the nine ecological groups will have a ≥60 per cent chance of persistence in the Wolastoq/SJR watershed in the next 25 years.

The PTM expert process identified 23 conservation strategies and combination strategies that were evaluated based on their relative benefit, cost and feasibility. A complementarity analysis was conducted to determine the optimal combination of strategies that, when implemented together, would maximize the total number of ecological groups secured to a near-60 per cent probability of persistence. The top three are highlighted in this report, with costs incurred annually over the next 25 years:

- **Option 1** provides the greatest benefits for biodiversity and includes implementation of 15 strategies which would secure seven out of nine ecological groups (40 species), with a minimum of roughly 60 per cent probability of persistence, at an estimated cost of $25.8 million per year.
- **Option 2** secures six of the nine ecological groups (34 species) to at least a 60 per cent probability of persistence, through land management in combination with riparian, wetland and aquatic habitat management and policy, with associated costs of $8.7 million per year.
- **Option 3** secures five of the nine ecological groups (30 species) to at least a 60 per cent probability of persistence through land management across public, private and forested lands, at a cost of $1.2 million per year.

Notably, two important ecological groups – bats (little brown myotis, northern myotis, tri-colored bat) and forest trees (butternut, black ash, eastern hemlock) – contain some highly threatened species and were considered unlikely to recover in the region based on expert judgement and current information, even with the implementation of all conservation strategies. Consequently, these species will require additional funding over the long term to invest in new, innovative solutions and technologies to ensure their survival.

While PTM is a rapid approach to identify and prioritize strategies for managing multiple threats, it requires a similar fast response of implementation of actions on the ground to effectively safeguard and recover species. For example, the identification and subsequent protection of important habitat for species at risk, including bats, was identified as a priority activity under Strategy 1. Conservation investments in the region would help to mitigate human-caused threats to biodiversity, create jobs, and mitigate and adapt to climate change, while ensuring a sustainable environment and economy for the people of New Brunswick.

Background

Nature is declining at an alarming and unprecedented rate. It is estimated that globally, one million species are already at risk of extinction[2], with thousands of species becoming extinct each year.[3]

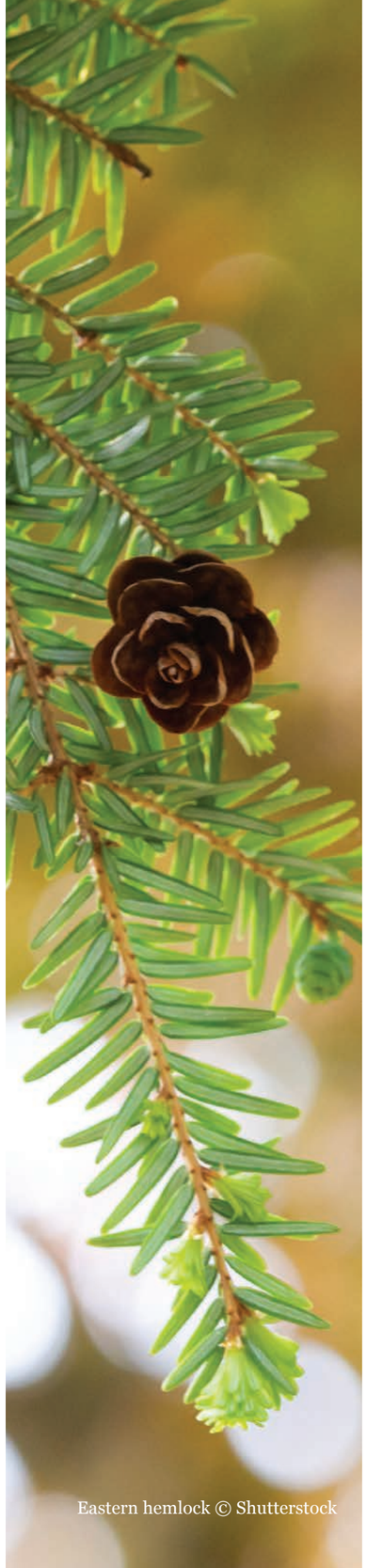
There is a growing consensus among conservation practitioners in Canada that we need to collectively shift our approach to species at risk recovery.

Eastern painted turtle
© Shutterstock

The primary driver of biodiversity loss is land- and sea-use change — 77 per cent of land (excluding Antarctica) and 87 per cent of oceans are modified by human activity.[4] [5] [6] Overexploitation of species and resources, climate change, pollution and invasive species are also pervasive.

WWF-Canada's *Living Planet Report Canada (2017)* found widespread and dramatic declines in Canada's native monitored wildlife populations — from marine fish in Atlantic Canada to grassland birds in the prairie provinces and caribou in the far north. But, perhaps the most worrisome finding in the 2017 LPRC was the ongoing decline of Canada's at-risk vertebrate species — those legally protected by the federal Species at Risk Act (SARA) — whose monitored populations declined by an average 28 per cent from 2002 to 2014. The rate of decline in these populations appears to have worsened since the enactment of SARA[7]. WWF-Canada's recent *Living Planet Report Canada (2020)* took a broader look at species of conservation concern in Canada by examining population trends of species that are scientifically assessed as being at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The analysis found that monitored populations of vertebrate species assessed as at risk by COSEWIC declined, on average, by 59 per cent from 1970 to 2016.[8]

There is a growing urgency to address the issues facing species at risk; however, the SARA process is plagued by process delays, and as a result it is very difficult for species to recover. For example, of the 488 wildlife species that had been reassessed by COSEWIC as of 2019, most species (82 per cent) remained at the same status or were reassessed at a higher risk category, while only 18 per cent of species saw their status improve.[9]



Eastern hemlock © Shutterstock

The development and implementation of management actions are also frequently delayed, further compounding a lack of species at risk recovery. For instance, the median time to publication of recovery strategies for species listed under SARA is approximately five years[10], which results in subsequent delays for the development of action plans and implementation of these conservation actions. Due to these process delays, a species can be assessed as at risk for many years, and in some cases more than a decade, before the appropriate recovery documents are completed and available to guide conservation actions. Furthermore, completion of these documents does not guarantee action on the ground, which is the critical component of species at risk recovery.

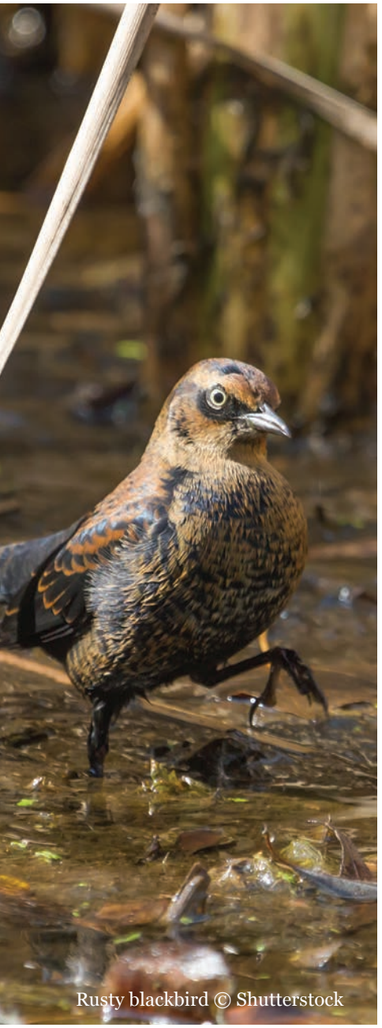
In a world of limited resources and ongoing biodiversity loss, priority should be given to those actions that benefit the greatest number of species.

Typically there have been a lack of funds available to implement all of the actions identified in recovery documents to recover at-risk species across the country — experts state that an increase in funding as well as new sources of revenue are needed.[11] A comprehensive study of species at risk in Canada states that current resourcing is generally devoted to "front end" processes like assessments and listing, as opposed to the implementation of recovery actions.[12] Moreover, where funding does exist, expenditures have fallen short of total funding asks. For example, funds for the Aboriginal Fund for Species at Risk (AFSAR) program through Environment and Climate Change Canada and Fisheries and Oceans Canada was significantly over-subscribed between 2011–2016, with a total funding ask exceeding the actual value of funded agreements by almost double.[13] With the number of species at risk increasing and resources for recovery and protection remaining insufficient and underspent, there is an urgent need to transform how we prioritize and recover species in Canada.

There is a growing consensus among conservation practitioners in Canada that we need to collectively shift our approach to species at risk recovery, as recovery of species requires a sustained effort, including significant, long-term funding, as well as sustained human capacity. For example, if conservation efforts are going to be successful, then species at risk recovery requires both an increase in financial resources and a prioritized approach to how environmental funds are spent[14] [15] — more specifically, prioritizing the actions that should be undertaken to provide the greatest benefits for multiple species.[16]

Introduction to Priority Threat Management

Priority threat management (PTM) is an emerging conservation decision-making framework that is garnering significant attention around the world.



Rusty blackbird © Shutterstock

This planning approach, pioneered by Dr. Tara G Martin (Conservation Decisions Lab, University of British Columbia) and her team, looks at species protection, recovery and threat management in terms of maximizing potential cost-benefit savings. **The PTM methodology determines how budgets can be best allocated to benefit the greatest number of species.**[17] It offers an integrated, ecosystem-based, multi-species approach that helps to ensure that investment is directed at the actions that have the greatest overall impact. The PTM approach has been applied (and partially implemented) to over one third of the Australian continent, with recent application in Canada, including the South of the Divide in Saskatchewan[18] [19], the Fraser River Estuary of British Columbia[20], the Kootenay Bioregion and the Central Coast.[21]

This decision support framework differs from other approaches (e.g., legislated recovery planning under the federal Species at Risk Act and Open Standards for the Practice of Conservation[22]). For instance, in Canada, the **costs, benefits and feasibilities** of management actions are not included in other conservation planning tools[23] or when developing recovery strategies[24] and actions plans[25] under SARA. Consequently, the full cost of recovering any given species is unknown. By including these considerations, PTM can therefore help inform a more efficient use of resources in a resource-constrained world. Lack of consideration for costs, benefits and feasibilities is particularly problematic for implementation of single species approaches (rather than ecosystem-based management)[26] and when pressure to recover iconic or charismatic species is high.[27] Without information around the benefits and feasibilities of the conservation actions being implemented, a species with a low likelihood of recovery may be prioritized. **Finally, the PTM approach to prioritizing conservation actions rather than individual species helps to facilitate a more holistic multispecies or ecosystem approach to conservation, which is useful for maximizing the recovery of many species.**[28]

Monarch butterflies © Shutterstock

Key Terms

Benefits: an estimation of how much a conservation strategy will help to improve an ecological group's probability of persistence

Business-as-usual scenario: represents the current level of investment in the Wolastoq/Saint John River watershed with no additional investments in conservation

Combination strategy: the combination of individual strategies that are anticipated to have synergistic effects when implemented together, as identified by the expert group

Costs: the estimated costs associated with implementing a conservation strategy for a given ecological group, above and beyond current conservation action

Cost-effectiveness: a measure of the effectiveness of the action, calculated using its estimated benefit and feasibility, relative to the costs of implementing the action

Ecological group: a group of species and/or communities that are anticipated to have a similar response to threats and management actions

Feasibility: the likelihood of a conservation action being implemented — considering social, economic and political circumstances — and the probability that the action is successful once implemented

Nature-based climate solutions: land-and sea-based activities that support both climate change mitigation and biodiversity conservation (protection, restoration, and sustainable management)

Probability of persistence: defined for this analysis as the probability that a species or population will persist at a functioning level over the next 25 years (the time period considered in the analysis)

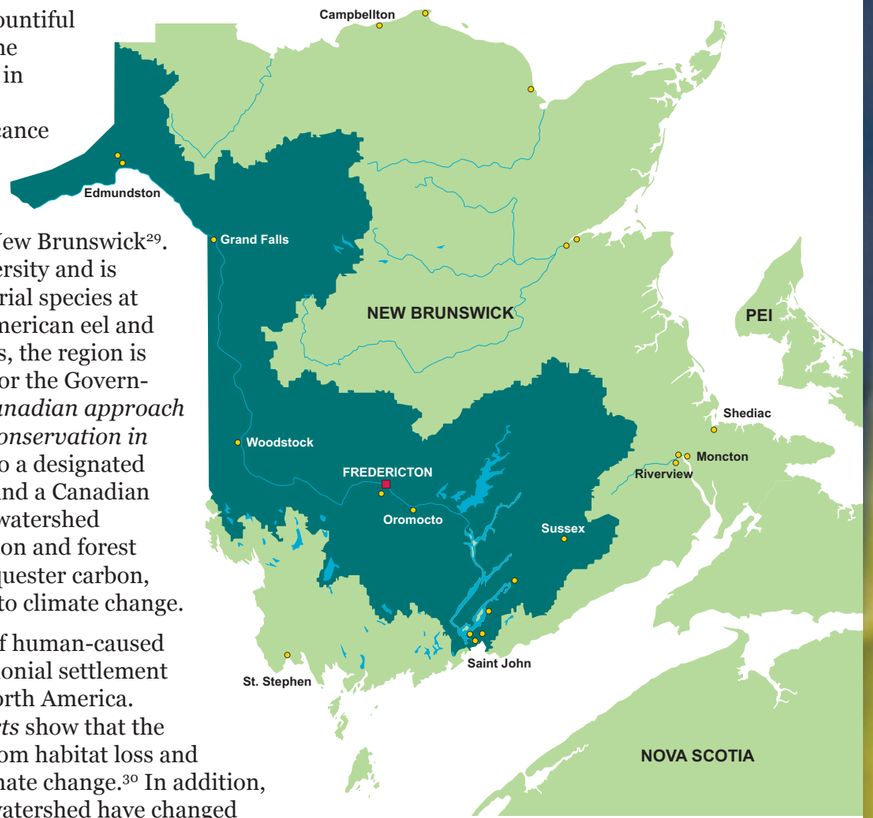
Recovery: occurs when a species population increases to the point where it is no longer considered at risk

Strategy: a set of similar conservation actions that will likely have a positive effect on the ecological groups included in this analysis

Testing the Priority Threat Management approach in New Brunswick

The PTM process for the Saint John River (SJR), also known as the Wolastoq, watershed represents the first application of the PTM framework in Eastern Canada.

Wolastoq means “beautiful and bountiful river” in the Maliseet language. The Wolastoq/SJR is the longest river in Eastern Canada and is of cultural, historical and recreational significance to the many people that call this region home. The Wolastoq/SJR has a basin area of over 55,000km² — half of which is in New Brunswick[29]. The region is a hotspot for biodiversity and is home to many aquatic and terrestrial species at risk, including the wood turtle, American eel and Atlantic salmon. For these reasons, the region is also considered a priority region for the Government of Canada under the *Pan-Canadian approach to transforming Species at Risk conservation in Canada*. The Wolastoq/SJR is also a designated National Historic Site of Canada and a Canadian Heritage River. The surrounding watershed contains vast amounts of soil carbon and forest biomass that help to store and sequester carbon, acting as a nature-based solution to climate change.



This area also has a long history of human-caused threats, with over 400 years of colonial settlement history — some of the oldest in North America. WWF-Canada’s *Watershed Reports* show that the region is presently under stress from habitat loss and fragmentation, pollution, and climate change.[30] In addition, the forests of the Wolastoq/SJR watershed have changed — large expanses of old growth forest have been lost due to the effects of hundreds of years of logging activity, jeopardizing the health of the watershed.

Jurisdiction

Collective efforts from government, industry, Indigenous communities and other organizations are needed to effectively safeguard biodiversity and mitigate and adapt to climate change.

- **Indigenous lands, waters and rights:** The Wolastoqiyik (Maliseet people) have lived throughout the Wolastoq/SJR watershed for more than 10,000 years, thoughtfully stewarding the lands and waters of the region and relying on their bounty. Traditional social and economic practices of the Wolastoqiyik have eroded over the years, as they’ve witnessed the ongoing disruption and degradation of a previously intact ecosystem. The Government of Canada is working with Indigenous groups in New Brunswick to renew the nation-to-nation relationship through announcements of Addition to Reserves,[31] co-development of agreements to support the implementation of Aboriginal and treaty rights for some Indigenous communities in the province,[32] and to honor the Supreme Court ruling that recognizes the right of First Nations to earn a moderate livelihood from fishing and hunting,[33] though some tensions with the Wolastoqiyik remain.[34]
- **Crown lands and governances:** Approximately 50 per cent of the land-base in New Brunswick is Crown land (also known as public land) — significantly more than other provinces and territories (e.g., 12 per cent of land in Prince Edward Island and 26 per cent of land in Nova Scotia is Crown land). In New Brunswick, only 4.6 per cent of terrestrial and freshwater areas are formally protected[35] — less than half of these protected areas are in the Wolastoq/SJR watershed. In addition, less than a third of Crown lands have been set aside for conservation purposes, which includes water-course and wetland buffers, conservation sites, deer wintering areas and other habitats. Yet, the level of protection for these areas is limited and some are still open to industry over the long term, so their conservation value is short-lived.
- **Corporate responsibility:** Within the province, a handful of companies dominate the natural resource sectors of forestry and agriculture. Together, these companies are considerable employers for the province of New Brunswick. Their broad reach and impact on the landscape situates these companies as necessary allies in the recovery and protection of species at risk in the region.

Species at risk in New Brunswick:

There are nearly 90 species listed provincially as at risk in New Brunswick, and roughly half frequent the Wolastoq/SJR watershed. New Brunswick’s outdated species at risk legislation was overhauled in 2012 when the *Endangered Species Act* was replaced with *New Brunswick’s Species at Risk Act* (NB SARA) to reduce discretion associated with listing species and mandated recovery planning.[36] However, a 2020 report examining New Brunswick’s provincial species at risk legislation showed that the Minister of Natural Resources and Energy Development has failed to meet many of the Act’s expectations[37]. For example, no steps have been taken to protect the tri-coloured bat and 23 other endangered species under the NB SARA.

© Shutterstock

© Emily Giles/WWF-Canada

Priority Threat Management process

The PTM process relied on information on biodiversity threats and related conservation actions from local experts. Consequently, multiple workshops were held to first present the potential benefits of the PTM analysis for the region, and then to elicit information from experts and practitioners with extensive knowledge on the ecology and management of species of conservation concern in the Wolastoq/SJR watershed.

A technical workshop was attended by 28 experts from scientific research institutions, Indigenous communities, federal (e.g., Fisheries and Oceans Canada, Environment and Climate Change Canada) and provincial government, environmental non-governmental organizations, and industry. The group of experts scoped the PTM project by defining a common objective and identifying species and ecosystems of conservation concern for inclusion in the analysis (Appendix I). Experts then worked to identify key threats and develop conservation actions and strategies to safeguard and recover those species and ecosystems within the Wolastoq/SJR watershed. They also estimated the costs, benefits and feasibilities of the proposed management actions.[38]

Stakeholder engagement: A diverse range of stakeholders and rightsholders (40) were invited to a workshop to learn about the proposed PTM project for the Wolastoq/SJR watershed.

Technical workshop: A three-day technical workshop was held to elicit information from experts and practitioners (28) with extensive knowledge on the ecology and management of species of conservation concern in the Wolastoq/SJR watershed.

Review workshop: Participants of the PTM pilot project in the Wolastoq/SJR watershed were invited to review and discuss the preliminary/ draft results of the analysis – identifying key concerns and considerations for finalization.

2019: FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC
2020: JAN | FEB | MAR | APR

Data collection: WWF-Canada and UBC drafted a species list for inclusion in the PTM process. For each species, data on threats and associated recovery actions were compiled and summarized into preliminary ecological groupings.

Analysis: The PTM analysis was conducted using the data collected at the 3-day technical workshop in addition to ongoing elicitation of data from key experts in the field.

Finalization of analysis: Experts were invited to provide final edits as co-authors of the PTM Wolastoq/SJR watershed manuscript.

Implementation: With funding from WWF-Canada, three non-government organizations within the Wolastoq/SJR watershed began implementation of priority aquatic actions to reverse the decline of wildlife.

A series of analyses were conducted using the data gathered throughout the technical workshop. For instance, the cost-effectiveness of management strategies was assessed by integrating estimates of benefits, costs and feasibilities, and subsequently ranking strategies based on cost-effectiveness scores. However, this approach to prioritizing conservation strategies does not account for potential overlap in benefits when two or more actions are implemented together, and therefore does not necessarily maximize the benefits of management (i.e., increase the probability or persistence for the most ecological groups).[39] [40] Consequently, a complementarity analysis was conducted to determine the optimal combination of strategies that, when implemented together, would maximize the total number of ecological groups secured to a near-60 per cent probability of persistence. The result of the PTM analysis — including the optimal sets of conservation strategies — are outlined below.

© Jessica Currie/WWF-Canada

GROUP OF EXPERTS

1. Define objective

Identify the optimal set of strategies that will maximize the number of species or communities of conservation concern that are likely to be secured over a 25-year time period, while also minimizing the costs of management.

2. Identify species & ecosystems of conservation concern

45 at-risk species and one forest community, grouped into nine ecological groups.

3. Identify key threats, conservation actions & strategies

Actions were grouped into **16** high-level management strategies based on similarities associated with conservation actions. **Seven** combinations of multiple strategies were also included, where synergistic effects of implementation were anticipated by the experts.

ACTION + ACTION → STRATEGY
ACTION + ACTION → STRATEGY
STRATEGY + STRATEGY → COMBO

4. Estimate the costs & feasibilities of each action

Experts estimated the annual costs of implementing each action over a 25-year period. The probability of uptake or implementation (social/political feasibility) and the probability of success once implemented (technical feasibility) were also estimated and used to calculate the overall feasibility of each action.

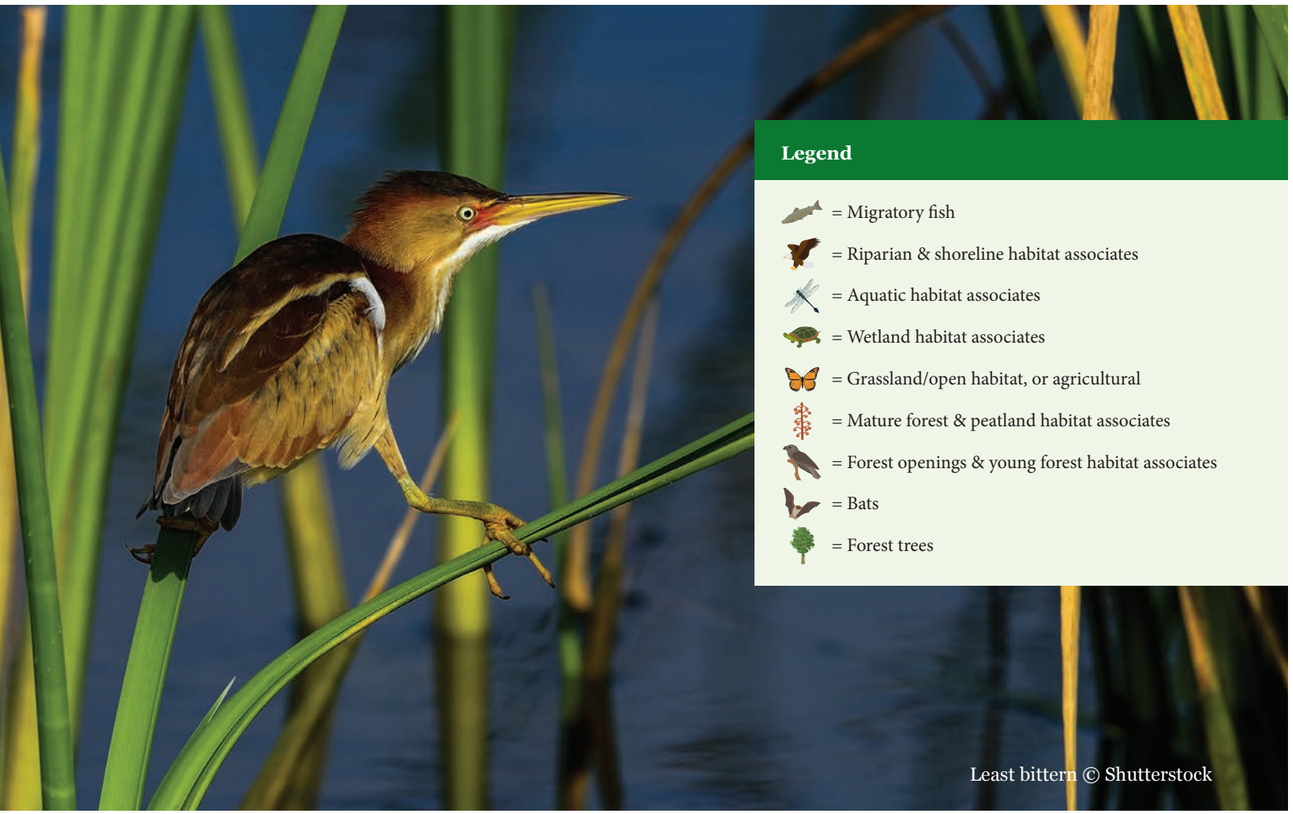
5. Estimate the benefit of each strategy

Experts estimated the benefit of each strategy relative to a baseline scenario of business as usual, assuming all identified actions included within the strategy would be implemented.

Wolastoq/Saint John River watershed

Results of the Priority Threat Management analysis

Sixteen conservation strategies and seven combination strategies were developed through the PTM process (Table 1). Under a business-as-usual scenario that represents the current level of investment in the Wolastoq/SJR watershed (i.e., no additional investment), experts predicted that *none* of the nine ecological groups (containing 45 species and one forest community) would achieve a 60 per cent chance of persisting at a functional level over the next 25 years, reinforcing the need for immediate and targeted conservation action.



Legend

- = Migratory fish
- = Riparian & shoreline habitat associates
- = Aquatic habitat associates
- = Wetland habitat associates
- = Grassland/open habitat, or agricultural
- = Mature forest & peatland habitat associates
- = Forest openings & young forest habitat associates
- = Bats
- = Forest trees

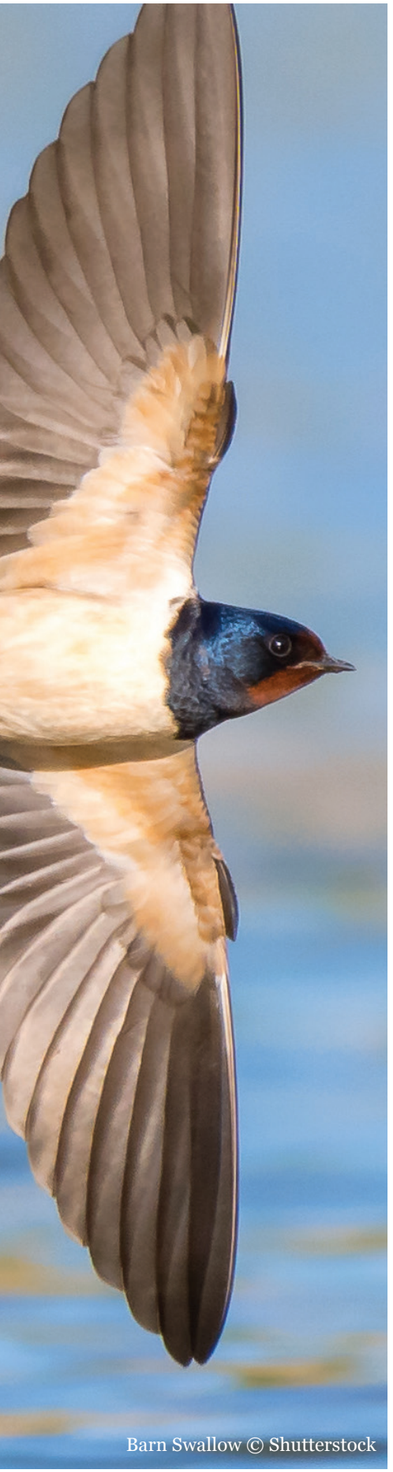
Least bittern © Shutterstock

Table 1. List of management strategies considered in the PTM analysis for the Wolastoq/SJR watershed, and the associated costs and benefits for each. A ✓ represents an ecological group that would be secured, through implementation of the management strategy, to a ~60% probability of persistence over 25 years. See Appendix I for a list of species included within each ecological group.

INDIVIDUAL STRATEGIES	Cost per Year[A]									
Business as usual	$0	-	-	-	-	-	-	-	-	-
S1 Public land management	$61,405	-	-	-	✓	-	✓	-	-	-
S2 Forestry land management	$117,807	-	✓	-	✓	-	✓	✓	-	-
S3 Private/agricultural land management	$1,039,952	-	-	-	✓	-	-	-	-	-
S4 Wetland/aquatic habitat management	$1,206,655	-	-	-	✓	-	-	-	-	-
S5 Dam discharge flow management	$5,462,784	-	-	-	-	-	-	-	-	-
S6 Removal of Mactaquac Dam	$19,923,782	-	-	-	-	-	-	-	-	-
S7 Illegal and incidental take policy	$618,660	-	-	-	-	-	-	-	-	-
S8 Wetland policy and regulation	$307,654	-	-	-	✓	-	-	-	-	-
S9 Water quality management	$505,423	-	-	-	✓	-	-	-	-	-
S10 Breeding/reintroduction of aquatics	$130,462	-	-	-	-	-	-	-	-	-
S11 Disease management for bats	$40,907	-	-	-	-	-	-	-	-	-
S12 Forest pest management	$17,900	-	-	-	-	-	-	-	-	-
S13 Invasive species management	$962,704	-	-	-	-	-	-	-	-	-
S14 Predator management	$184,619	-	-	-	-	-	-	-	-	-
S15 Pollution reduction and management	$263,806	-	-	-	-	-	-	-	-	-
S16 Climate change policies and actions	$437,882	-	-	-	-	-	-	-	-	-

COMBINATION STRATEGIES	Cost per Year									
S17 Land management (S1, S2, S3)	$1,219,164	-	✓	-	✓	✓	✓	✓	-	-
S18 Riparian, wetland and aquatic management and policy (S4, S5, S8, S9)	$7,482,514	-	✓	✓	✓	-	-	-	-	-
S19 Policy development/implementation (S7, S8, S15, S16)	$1,628,002	-	-	-	✓	-	-	-	-	-
S20 Dam management and breeding/reintroduction of aquatics (S5, S10)	$5,593,246	-	-	-	✓	-	-	-	-	-
S21 Land and predator management (S1, S3, S14)	$1,285,977	-	✓	-	✓	-	✓	-	-	-
S22[B] All strategies (except removal of Mactaquac Dam: S6)	$11,358,618	-	✓	✓	✓	✓	✓	✓	-	-
S23[B] All strategies (except dam flow management for Mactaquac Dam: S5)	$25,819,617	✓	✓	✓	✓	✓	✓	✓	-	-

A All cost values presented are in present values, calculated using an annual discount rate of four per cent over the 25-year time period.
B Two individual strategies — dam discharge flow management from Mactaquac and other dams (Strategy 5), and removal of Mactaquac Dam and flow discharge management for other dams (Strategy 6) — were designed to be mutually exclusive. Accordingly, there are two 'All strategies' combinations that were investigated during the workshop.



Barn Swallow © Shutterstock

The combination strategies (strategies 17–23) provided greater expected benefits than any individual strategy alone, highlighting the need for implementation of multiple strategies in the Wolastoq/SJR watershed. Moreover, the complementarity analysis identified the optimal combination of strategies, that when implemented together would maximize the number of ecological groups secured to a 60 per cent probability of persistence.

The analysis identified Strategy 23 (all strategies except dam flow management) as the combination strategy that would secure the greatest number of ecological groups in the watershed. However, implementing all the strategies within Strategy 23 at once would face considerable financial and political challenges and therefore a tiered approach of strategies was identified to prioritize resource allocation (Figure 1). As a first step, existing conservation funds and efforts should be reallocated to focus on land management (Strategy 17), which would benefit the greatest number of ecological groups (5) at the lowest cost. Once land management is adequately resourced, the next step should be to focus on aquatic management (Strategy 18) to secure an additional ecological group to a 60 per cent probability of persistence. This step would secure the same ecological groups as Strategy 22, but at a lower cost. Finally, conservation efforts and funding should be targeted to all remaining strategies (Strategy 23), which would secure seven ecological groups, including migratory fish.

Figure 1. The top three strategies identified through the PTM process in the Wolastoq/SJR watershed to prioritize resource allocation to secure species to a 60 per cent probability of persistence over 25 years


© Rhonda Richard

Table 2. List of species and communities secured to a near-60 per cent probability of persistence for each of the top three strategies identified through the process

Option 1 – Strategy 23	Option 2 – Strategy 17 & 18	Option 3 – Strategy 17
Alewife (Gaspereau)	Anticosti aster	Anticosti aster
American eel	Appalachian hardwood forest	Appalachian hardwood forest
Anticosti aster	Bald eagle	Bald eagle
Appalachian hardwood forest	Bank swallow	Bank swallow
Atlantic salmon	Barn swallow	Barn swallow
Atlantic sturgeon	Bicknell's thrush	Bicknell's thrush
Bald eagle	Black-foam lichen	Black-foam lichen
Bank swallow	Bobolink	Bobolink
Barn swallow	Canada warbler	Canada warbler
Bicknell's thrush	Chimney swift	Chimney swift
Black-foam lichen	Cobblestone tiger beetle	Cobblestone tiger beetle
Bobolink	Common nighthawk	Common nighthawk
Canada warbler	Eastern painted turtle	Eastern painted turtle
Chimney swift	Eastern whip-poor-will	Eastern whip-poor-will
Cobblestone tiger beetle	Eastern wood-pewee	Eastern wood-pewee
Common nighthawk	Evening grosbeak	Evening grosbeak
Eastern painted turtle	Furbish's lousewort	Furbish's lousewort
Eastern whip-poor-will	Least bittern	Least bittern
Eastern wood-pewee	Monarch	Monarch
Evening grosbeak	Olive-sided flycatcher	Olive-sided flycatcher
Furbish's lousewort	Pinedrops	Pinedrops
Least bittern	Prototype quillwort	Rusty blackbird
Monarch	Pygmy snaketail	Short-eared owl
Olive-sided flycatcher	Rusty blackbird	Snapping turtle
Pinedrops	Short-eared owl	Southern twayblade
Prototype quillwort	Skillet clubtail	Transverse lady beetle
Pygmy snaketail	Snapping turtle	Wood thrush
Rusty blackbird	Southern twayblade	Wood turtle
Short-eared owl	Transverse lady beetle	Yellow rail
Shortnose sturgeon	Wood thrush	Yellow-banded bumblebee
Skillet clubtail	Wood turtle	
Snapping turtle	Yellow lampmussel	
Southern twayblade	Yellow rail	
Striped bass	Yellow-banded bumblebee	
Transverse lady beetle		
Wood thrush		
Wood turtle		
Yellow lampmussel		
Yellow rail		
Yellow-banded bumblebee		

Strategy 23 is the only option likely to secure the persistence of migratory fish

Option 1: Strategy 23

The analysis identified Strategy 23 as the combination strategy that would secure the greatest number of ecological groups in the watershed. Under this approach, experts estimate that seven of the nine ecological groups (40 species) will achieve a roughly 60 per cent chance of persisting.

Implementing Strategy 23 comes with a price tag of $25.8 million per year ($645.5 million total over 25 years), which is largely driven by the cost of removing the Mactaquac Dam — an approach that would ensure the long-term resilience and health of the St. John River ecosystem. Until the dam is removed, migratory fish, such as Atlantic salmon, will be unable to move freely throughout the watershed and access spawning grounds and areas with ideal water temperatures. Removal of the Mactaquac Dam alone, however, cannot help migratory fish achieve a 60 per cent probability threshold. Dam removal should therefore be combined with all other strategies to facilitate the long-term success of the migratory fish group. Removal of the Mactaquac Dam, combined with discharge management and improved fish passage for an additional five dams is estimated to cost a total of $498 million — roughly 77 per cent of the total cost of implementation of all strategies.

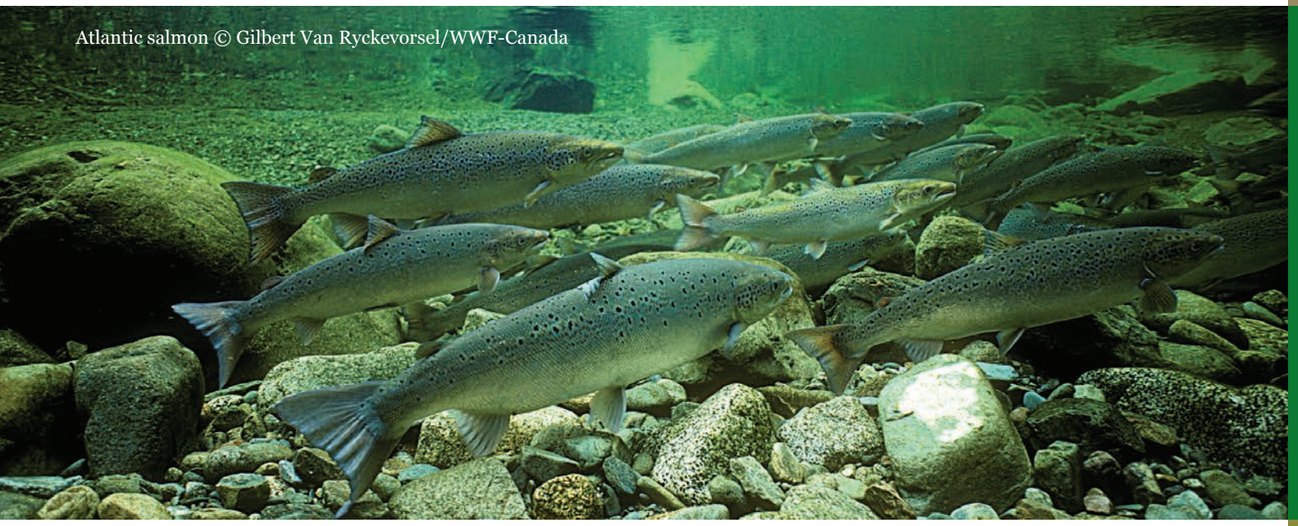

Atlantic sturgeon © Shutterstock

UNDERSTANDING THE COSTS: Implementation of Option 1 is estimated to cost $25.8 million per year — approximately 60 per cent of the newly imposed tax relief for commercial and industrial owners in the province.[42] [43]

When discussing Strategy 23, the expert group highlighted the overall need for a broad-scale system-level approach, as well as the benefits that restoring a healthy, free-flowing river would provide to the watershed. The issue of fragmentation isn't specific to the Mactaquac Dam, however. While the Mactaquac Dam is the largest and furthest down the system, multiple dams are currently fragmenting the natural habitat of the Wolastoq/SJR watershed, disrupting the natural flows of water that are essential to a resilient ecosystem. All hydroelectric dams within the watershed were built prior to the 1970s,[41] and end-of-life considerations will need to be addressed in the near term. The Mactaquac Dam was the only dam considered for removal in the PTM process, largely because of the timely decisions surrounding end-of-life options for this large, reservoir-based hydropower facility.

Because the analysis was conducted at the level of the ecological group, and the response of individual species to management interventions may still vary within the unit of analysis, some of the experts anticipate that Atlantic salmon will likely have a more pessimistic outcome compared to the rest of the migratory fish. Even with the implementation of all 15 strategies, Atlantic salmon is unlikely to experience substantial benefits, especially as climate change intensifies.

While the strategies identified in Option 1 are needed to improve biodiversity within the Wolastoq/SJR watershed, it is recognized that it will be challenging to implement all strategies rapidly and simultaneously given competing financial priorities within the province, including healthcare, education and support for small businesses. However, the results of the PTM analysis showed that this combination of strategies is likely to provide the best benefit to biodiversity in the region and is the only option likely to secure the persistence of migratory fish.



Atlantic salmon © Gilbert Van Ryckevorsel/WWF-Canada

Policy considerations:

Dam removal: The cost of dam removal and discharge management is outside of the current plan for the dam, which is currently outlined in the "Mactaquac Life Achievement Project." This project, identified as the preferred option in 2017, focuses on maintaining existing concrete structures and associated mechanical equipment until 2068 to reach a 100-year service life of the hydropower station.[44] Rehabilitation activities associated with the "Mactaquac Life Achievement Project" are expected to take place between 2020 and 2036 pending economic and environmental regulatory approvals. While dam removal was not selected by New Brunswick Power's Board of Directors in 2017, it was the only end-of-life option for the dam that was anticipated to have positive potential outcomes for wildlife habitats and species at risk.[45] Because of the anticipated ecosystem benefits, the PTM expert group developed a specific Mactaquac Dam removal strategy (Strategy 6) as part of the PTM analysis in order to provide maximum benefit to migratory fish.

Barn swallows © Shutterstock

Option 2: Strategy 17 & 18

The combination of Strategies 17 and 18 delivered the second greatest benefit for species in the watershed at a lower cost. This option includes the combination of land management across tenures (S17: S1 + S2 + S3) along with riparian, wetland and aquatic habitat management and policy (S18: S4 + S5 + S8 + S9). This combination of strategies secures the same ecological groups as Strategy 23, except for migratory fish, due to the exclusion of the large dam removal. This option, which includes land management ($1.2 million/year), in combination with riparian, wetland and aquatic habitat management and policy ($7.5 million/year) comes with an implementation cost of $8.7 million per year and secures six ecological groups (34 species) with at least a 60 per cent probability of persisting.

© Shutterstock

UNDERSTANDING THE COSTS:
The $7.5 million/year price tag for aquatic habitat and management — or $8.7 million/year when combined with the land management strategy — is roughly equivalent to the cost of three coffees per New Brunswicker per year.

Policy considerations

Wetland policy: Actions designed to encourage and support improvements to the policy for small wetlands were included in Strategies 4 and 8. In New Brunswick, wetlands are managed through *the New Brunswick Wetlands Conservation Policy* and the *Watercourse and Wetlands Alteration Regulation* under the *Clean Water Act*. The current policy, however, only applies to regulated wetlands that are contiguous to a watercourse or those that are ≥1 hectare in size[46] (about the size of two football fields). Anything else lacks adequate policy protection. Consequently, the health and natural function of small wetlands are not protected despite their importance for habitat and implications for land-use planning and management in forestry and agriculture. This is particularly important as the number of wetlands per area increases with decreasing wetland size,[47] meaning small wetlands are significant.

© Graeme Stewart-Robertson

Environmental flow management and fish passage: The quantity, timing and quality of water flows, also known as environmental flows, are intrinsically tied to the health of freshwater and estuarine ecosystems. Dams severely fragment freshwater ecosystems, affecting the natural flow of water. Thus, management requires a balance of maintaining ecological integrity and sustainable human use for renewable energy. Within the Wolastoq/SJR, minimum maintenance flows for dams need to be adjusted to ensure discharge levels enhance benthic invertebrate and fish productivity. There are six dams included within this proposed PTM conservation action: Mactaquac, Beechwood, Tobique, Grand Falls, Tinker and Sisson. Moreover, because dams inhibit fish movement throughout the watershed, it is recommended that fish passage be improved by installing or enhancing downstream collection and/or bypass for migratory fish species (Strategy 5). Improvements associated with environmental flow management and fish passage will help to ensure a more prosperous freshwater ecosystem while recognizing competing human uses.

Restoration: Hundreds of years of human activity have threatened the Wolastoq/SJR watershed, resulting in habitat loss and degradation, invasive species and pollution. Moreover, further degradation exacerbates the environmental crises that we're facing today. Protection of intact ecosystems and sustainable management of degraded ecosystems will not adequately address biodiversity loss and climate change — we must also rebuild and restore what's been lost. The United Nations Decade on Ecosystem Restoration is based on this concept. Likewise, experts involved in the development of the PTM conservation strategies identified the critical need for restoring the Wolastoq/SJR watershed to a healthier and more resilient ecosystem (Strategy 4).

Little brown myotis
© Sherri and Brock Fenton/WWF-Canada

Education: Knowledge is power. Education is a vital component to mitigation of biodiversity threats and climate change. Specific to the PTM analysis on the Wolastoq/SJR watershed, experts identified the need for education and integrated this action into many of the strategies developed. For example, communicating the importance of protecting wetlands — preventing the degradation of carbon stores (which would further accelerate the climate crisis) and habitat for species at risk — was a key component of Strategy 8. In addition, experts identified the need for public education on the integrity of shorelines and risks associated with development. This is particularly important for climate change adaptation as natural and resilient ecosystems can help to reduce the severity of extreme weather events such as flooding. Finally, there was a consensus that knowledge of best management practices in a variety of different industries — including agriculture — is needed to adequately reduce environmental impacts (Strategy 3).

Short-eared owl © Shutterstock

Atlantic salmon
© Gilbert Van Tyckevorsel/WWF-Canada

Snapping turtle © Shutterstock

Option 3: Strategy 17

While the single most effective strategy varies by ecological group, public, private and forestry land management (S17: S1 + S2 + S3) are anticipated to have the greatest overall benefits to biodiversity when implemented individually (Table 3). These have additional value when implemented together (Table 1). Land management across public, private and forestry lands is also anticipated to have synergistic effects, which could further enhance the benefits gained from implementation. This set of three strategies is therefore recommended under Option 3. A total of five ecological groups (30 species) are anticipated to have at least a 60 per cent probability of persistence if land management is implemented across multiple tenures, at a cost of $1.2 million per year.

Policy considerations

Protected and conserved areas: In 2019, the New Brunswick government committed to protecting 10 per cent of the province by 2020, effectively doubling the amount of conserved land within a span of 14 months with the support of $9.3 million under the federal government's Canada Nature Fund (currently only 4.6 per cent of terrestrial and freshwater areas are protected in New Brunswick).[48] Continued support for the designation of new protected areas in the region beyond 2020 is crucial to deliver clear benefits to biodiversity and ecosystems, as well as the benefits that humans derive from resilient systems, including clean air, carbon sequestration, pollination and avoidance of disease.[49] New protected areas will also require additional funding to ensure that they are afforded the necessary protections and management needed to recover biodiversity.[50] Strategy 1 included actions developed to achieve the protected area target, including the identification, prioritization and protection of areas of public land to contribute towards achieving the national target of protecting 30 per cent of lands and oceans by 2030 and enhancing cultural and functional connectivity on the landscape. Additionally, coordination between protected/conserved areas and species at risk legislation may help achieve conservation goals in the province. For instance, protected areas should be sited in areas with large carbon stores and high concentrations of species at risk.

Olive-sided
flycatcher
© Shutterstock

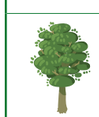
Land management: With over 80 per cent of the Wolastoq/SJR watershed covered in forest, forestry is one of the province's most widespread economic sectors.[51] Unlike many other provinces across Canada, only 50 per cent of forested lands are Crown-owned. The remaining areas comprise private woodlots (30 per cent) and industrial forestry (20 per cent).[52] For comparison, only six percent of forests are privately owned nationally.[53] While some forested areas are designated for protection and conservation — including riparian buffer zones for water quality — greater size, coverage, and enhanced management options are needed to safeguard and restore ecosystems and species within the Wolastoq/SJR watershed, especially as standards and their enforcement differ among private and Crown lands. While agricultural areas comprise a significantly smaller portion of land area within the Wolastoq/SJR watershed (six per cent), their impact on the ecosystem is also noteworthy. While some policy tools currently exist — including the Environmental Farm Plan[54] and the Environmentally Sustainable Agriculture program,[55] which are co-funded under the national-provincial *Canadian Agricultural Partnership* — more tools are needed to incentivize and compensate farmers for sustainable management and the implementation of conservation actions. The private/agricultural land management strategy (Strategy 3) was one of the most comprehensive strategies developed through the PTM process. The strategy includes development and implementation of an integrated conservation plan for private land, including the development of best management practices to minimize impacts of activities, development of incentive programs to protect species of conservation concern and restoration of degraded habitat. A capital investment endowment fund for private land purchases for conservation was also included.

UNDERSTANDING THE COSTS: Expenditures from the provincial Wildlife Trust Fund and Environmental Trust Fund for relevant protection, restoration, conservation and education projects within the Wolastoq/SJR watershed (2019–2020) total more than two-thirds of the estimated cost of land management. These funds represent a mere fraction of the total funding available through provincial, federal and private expenses for conservation including the Canada Nature Fund, EcoAction, Environmental Damages Fund, provincial, private and non-government organizations. Thus, while additional funding may be required to implement land management across tenures, simply reallocating funding to the priority actions identified through the PTM analysis may help to advance conservation goals in a more cost-effective and prioritized manner.

The role of targeted conservation action

While landscape-scale conservation actions may help maximize the total number of species conserved or recovered, there are species at risk that may require targeted, species-specific approaches to increase their probability of persistence. Consequently, if there is interest in recovering a specific ecological group, more targeted actions can be undertaken. Table 3 highlights the conservation strategy that provides the greatest benefit for each ecological group included in the PTM analysis.

Table 3. List of ecological groups and the individual strategies that provide the greatest benefit

Ecological group	Strategy with greatest benefits	Baseline probability of persistence	Estimated probability of persistence	Change in probability of persistence relative to baseline
	Removal of Mactaquac Dam and discharge flow management for other dams	37%	52%	+15%
	Forestry land management	51%	62%	+11%
	Public land management, dam discharge flow management, climate change policies and actions	53%	58%	+5%
	Public land management	57%	64%	+7%
	Private land management	45%	57%	+12%
	Forestry land management	53%	66%	+13%
	Forestry land management	46%	64%	+18%
	Disease management for bat species	27%	39%	+12%
	Forest pest management	17%	32%	+15%

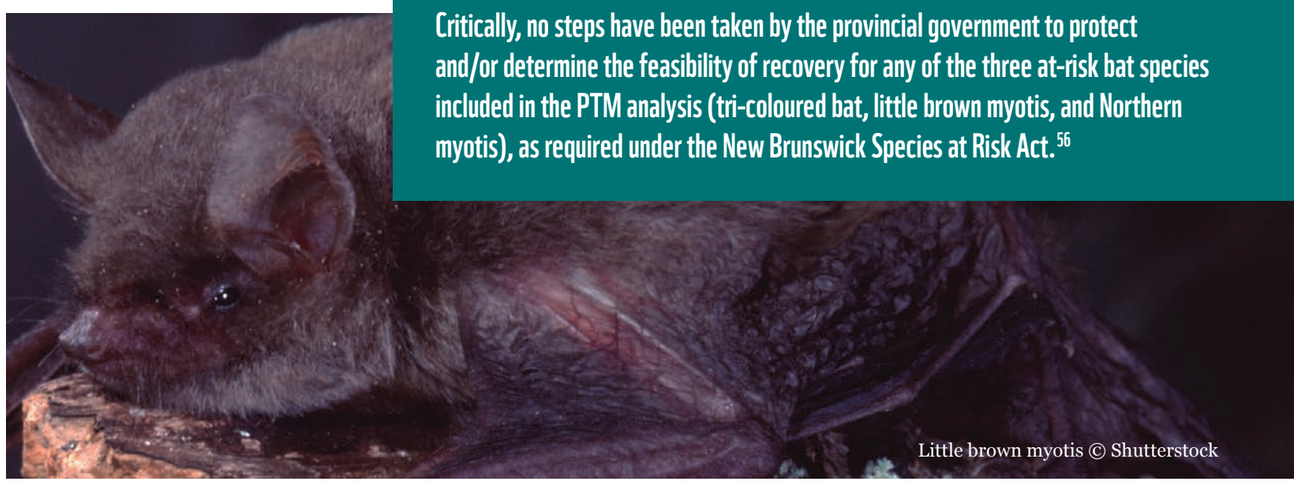
Bald eagle © Shutterstock

Canada warbler © Shutterstock

While there is a role and need for single-species approaches, not all strategies developed by the experts were predicted to result in high benefits because some species groups are experiencing threats that we do not currently have adequate solutions for. Notably, the strategies proposed by experts for bats and forest trees are not predicted to result in a high or even moderate chance of survival (<40 per cent probability of persistence), largely because the threats to these species are currently very high, and they require new and innovative solutions.

In the case of the forest trees group, implementation of the forest pest management strategy (Strategy 12) would result in an increase from a 17 to a 32 per cent probability for these tree species (butternut, black ash and eastern hemlock). The forest pest management strategy includes actions to address the butternut canker (an infection caused by a fungus), the emerald ash borer (a non-native beetle) and the hemlock woolly adelgid (a non-native aphid-like insect). These non-native forest insect pests and disease have caused extensive tree damage and mortality in the region, which in turn results in habitat degradation, biodiversity loss and a loss of ecosystem services such as carbon storage, and harvestable timber. While only three tree species at risk were included in the analysis, other tree species are also on the verge of decline from forest pests and may also benefit from the implementation or key learnings of this strategy. Ultimately, the conservation actions proposed by the expert participants under Strategy 12 were largely related to research and seed banking. Novel approaches with a high likelihood of success for the recovery of these trees were difficult to identify but are of critical importance. Further investment in research and development to tackle forest pests could potentially uncover new effective strategies for at-risk trees in the Wolastoq/SJR watershed. Without such an investment, it will be difficult to achieve an optimistic threshold to ensure the persistence of at-risk tree species over the long term.

Critically, no steps have been taken by the provincial government to protect and/or determine the feasibility of recovery for any of the three at-risk bat species included in the PTM analysis (tri-coloured bat, little brown myotis, and Northern myotis), as required under the New Brunswick Species at Risk Act.[56]



Little brown myotis © Shutterstock

Why Trees Matter

- Lands and waters can both actively reduce carbon dioxide through sequestration and by storing carbon over the long-term. There's a massive amount of carbon stored in wetlands, peatlands, forests and coasts. Capturing and storing carbon is critical in the fight against climate change, and nature can provide a solution. Healthy, resilient and diverse ecosystems such as forests store carbon, yet the loss of trees — through pests or other means — releases carbon into the atmosphere, thereby accelerating climate change. Healthy forests, therefore, provide many co-benefits beyond habitat for wildlife.
- WWF-Canada's *Wildlife Protection Assessment* identified the Wolastoq/SJR watershed to be an important region for new protected areas, due to the climate refuges and high densities of soil carbon found in the northern portion of the watershed, and the high densities of forest biomass and habitat for at-risk species in the lower portion of the watershed.

Butternut © Shutterstock

Local Partnerships

- The Atlantic Coastal Action Plan (ACAP) Saint John, the Kennebecasis Watershed Restoration Committee (KWRC) and the Nashwaak Watershed Association (NWA) are working with WWF-Canada to collaboratively address the aquatic habitat strategies prioritized through the PTM analysis. Together, the organizations have nearly 80 years of conservation experience in the Wolastoq/SJR watershed, with an emphasis on the implementation of restoration initiatives.
- These restoration projects aim to address the dominant threats of pollution, habitat loss and habitat fragmentation identified in WWF-Canada's Watershed Reports by restoring riparian buffer areas and in-stream habitat — actions identified in the PTM aquatic management strategy.
- The projects take place within the lower reaches of the Wolastoq, beginning in the summer of 2020. To begin, the project team spatially prioritized sites based on restoration need or potential. Once identified, on-the-ground conservation actions are being implemented, including revegetation and habitat improvement (i.e., removal of barriers, installation of fish passages, mitigation of contaminants and bank stabilization) of the Wolastoq/SJR watershed.


© KWRC


© KWRC


© KWRC


© Kristen Stanley/WWF-Canada

"The Kennebecasis Watershed Restoration Committee is very proud to be working alongside WWF-Canada to restore the health of the Wolastoq. We're working with landowners to repair and stabilize extremely eroded stream banks, and restoring the river system to a more natural state. This restoration work provides many benefits that are integral to regional and global ecosystem health – including benefits for aquatic species at risk like Atlantic salmon, Atlantic sturgeon, and striped bass."

– Ben Whalen, Project Manager, KWRC

Eastern whip-poor-will
© Shutterstock

Recommendations and next steps

While the majority of strategies are needed to safeguard and recover biodiversity in the Wolastoq/SJR watershed, strategies can be prioritized (time, capacity and financial resources) based upon the greatest overall benefits. Land management (Strategy 17) across multiple tenures including public, forestry and private/agricultural lands is estimated to have the greatest benefit for multiple ecological groups. Implementation of this strategy would come at a comparatively high benefit for biodiversity and feasibility of implementation, at a moderate cost. In addition to land management, riparian, wetland and aquatic habitat management and policy (Strategy 18) should also be prioritized, helping to secure an additional ecological group: aquatic species. Finally, to safeguard bats and tree species with low probabilities of persistence, we need to prioritize investment in research and development to pilot novel strategies, especially those that include co-benefits for climate change mitigation and adaptation.

While PTM is a rapid approach to identify priority strategies for managing multiple threats, it requires a similar response of swift implementation of actions on the ground to safeguard and recover species. In partnership with Atlantic Coastal Action Plan (ACAP) Saint John, the Kennebecasis Watershed Restoration Committee (KWRC) and the Nashwaak Watershed Association (NWA), WWF-Canada is building on previous on-the-ground conservation work in the Wolastoq/SJR watershed and has begun implementation of Strategy 4 (Wetland and Aquatic habitat management), which was identified as one of the priority strategies for implementation (Option 2). The results of the PTM analysis have helped leverage additional funding for the region — particularly through the Canada Nature Fund for Aquatic Species At Risk (CNFASAR) — to begin this important work in 2020. The implementation of priority actions within the Wolastoq/SJR watershed will mark the first ever implementation of PTM recommendations in Eastern Canada.

Through the PTM process, experts identified combination strategies that would have the greatest benefit for species and ecological communities of conservation concern. The transparency of the process and the results provides decision-makers with the opportunity to implement strategies based on the greatest benefit for multiple species, cost-effectiveness, or other factors including cultural, economic, or societal values and preferences. The participatory nature of the PTM process facilitated coordination and eventual collaboration among stakeholders. Importantly, PTM is a relatively rapid decision-making approach that is meant to be iterative and adaptable to incorporate new conditions and information as they become available. Research, management costs and ideas were shared in a safe and trusted environment and the process has already resulted in novel collaborations and projects in the Wolastoq/SJR watershed.

Appendix I – *Species and ecological communities of conservation concern included in the Wolastoq/Saint John River watershed PTM analysis.*

Ecological Group	Common Name	Scientific Name	Taxon	COSEWIC Status	SARA Status	Provincial Status
Migratory fish 	American eel	*Anguilla rostrata*	Fishes	Threatened	No Status	Threatened
	Atlantic salmon (Outer Bay of Fundy population)	*Salmo salar*	Fishes	Endangered	No Status	Endangered
	Atlantic sturgeon (Maritimes population)	*Acipenser oxyrinchus*	Fishes	Threatened	No Status	Threatened
	Shortnose sturgeon	*Acipenser brevirostrum*	Fishes	Special Concern	Special Concern	Special Concern
	Striped bass (Bay of Fundy population)	*Morone saxatilis*	Fishes	Endangered	No Status	Endangered
	Alewife (Gaspereau)	*Alosa pseudoharengus*	Fishes	Not Assessed	No Status	No Status
Riparian & shoreline habitat associates 	Anticosti aster	*Symphyotrichum anticostense*	Vascular Plants	Special Concern	Threatened	Endangered
	Furbish's lousewort	*Pedicularis furbishiae*	Vascular Plants	Endangered	Endangered	Endangered
	Cobblestone tiger beetle	*Cicindela marginipennis*	Arthropods	Endangered	Endangered	Endangered
	Bald eagle	*Haliaeetus leucocephalus*	Birds	Not at Risk	No Status	Endangered
Aquatic habitat associates 	Prototype quillwort	*Isoetes prototypus*	Vascular Plants	Special Concern	Special Concern	Endangered
	Pygmy snaketail	*Ophiogomphus howei*	Arthropods	Special Concern	Special Concern	Special Concern
	Skillet clubtail	*Gomphus ventricosus*	Arthropods	Endangered	Endangered	Endangered
	Yellow lampmussel	*Lampsilis cariosa*	Mollusks	Special Concern	Special Concern	Special Concern
Wetland habitat associates 	Least bittern	*Ixobrychus exilis*	Birds	Threatened	Threatened	Threatened
	Rusty blackbird	*Euphagus carolinus*	Birds	Special Concern	Special Concern	Special Concern
	Yellow rail	*Coturnicops noveboracensis*	Birds	Special Concern	Special Concern	Special Concern
	Eastern painted turtle	*Chrysemys picta picta*	Reptiles	Special Concern	No Status	No Status
	Snapping turtle	*Chelydra serpentina*	Reptiles	Special Concern	Special Concern	Special Concern

Ecological Group	Common Name	Scientific Name	Taxon	COSEWIC Status	SARA Status	Provincial Status
Grassland/ open habitat or agricultural associates 	Bank swallow	*Riparia riparia*	Birds	Threatened	Threatened	No Status
	Barn swallow	*Hirundo rustica*	Birds	Threatened	Threatened	Threatened
	Bobolink	*Dolichonyx oryzivorus*	Birds	Threatened	Threatened	Threatened
	Common nighthawk	*Chordeiles minor*	Birds	Special Concern	Threatened	Threatened
	Short-eared owl	*Asio flammeus*	Birds	Special Concern	Special Concern	Special Concern
	Wood turtle	*Glyptemys insculpta*	Reptiles	Threatened	Threatened	Threatened
	Monarch	*Danaus plexippus*	Arthropods	Endangered	Special Concern	Special Concern
	Yellow-banded bumblebee	*Bombus terricola*	Arthropods	Special Concern	Special Concern	No Status
	Transverse lady beetle	*Coccinella transversoguttata*	Arthropods	Special Concern	No Status	No Status
Mature forest & peatland habitat associates 	Canada warbler	*Cardellina canadensis*	Birds	Threatened	Threatened	Threatened
	Chimney swift	*Chaetura pelagica*	Birds	Threatened	Threatened	Threatened
	Eastern wood-pewee	*Contopus virens*	Birds	Special Concern	Special Concern	Special Concern
	Evening grosbeak	*Coccothraustes vespertinus*	Birds	Special Concern	Special Concern	No Status
	Olive-sided flycatcher	*Contopus cooperi*	Birds	Special Concern	Threatened	Threatened
	Wood thrush	*Hylocichla mustelina*	Birds	Threatened	Threatened	Threatened
	Black-foam lichen	*Anzia colpodes*	Lichens	Threatened	Threatened	No Status
	Pinedrops	*Pterospera andromedea*	Vascular Plants	Not Assessed	No Status	Endangered
	Southern twayblade	*Listera australis*	Vascular Plants	Not Assessed	No Status	Endangered
	Appalachian hardwood forest	(various species)	Vascular Plants	NA	NA	NA
Forest openings & young forest habitat associates 	Bicknell's thrush	*Catharus bicknelli*	Birds	Threatened	Threatened	Threatened
	Eastern whip-poor-will	*Antrostomus vociferus*	Birds	Threatened	Threatened	Threatened
Bats 	Little brown myotis	*Myotis lucifugus*	Mammals	Endangered	Endangered	Endangered
	Northern myotis	*Myotis septentrionalis*	Mammals	Endangered	Endangered	Endangered
	Tri-colored bat	*Perimyotis subflavus*	Mammals	Endangered	Endangered	Endangered
Forest trees 	Butternut	*Juglans cinerea*	Vascular Plants	Endangered	Endangered	Endangered
	Black ash	*Fraxinus nigra*	Vascular Plants	Threatened	No Status	No Status
	Eastern hemlock	*Tsuga canadensis*	Vascular Plants	Not Assessed	No Status	No Status

References

1 ECCC. 2019. Overview of the Pan-Canadian approach to transforming species at risk conservation in Canada. *Environment and Climate Change Canada*. Gatineau, Quebec. https://www.canada.ca.

2 IPBES. 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Diaz S. *et al*. *IPBES Secretariat*. Bonn Germany. https://ipbes.net.

3 Monastersky R. 2014. Biodiversity: Life – a status report. *Nature*. 516: 158-161. DOI: 10.1038/516158a.

4 Watson JE. Venter O. Lee J. Jones KR. Robinson JG. Possingham HP. *et al*. 2018. Protect the last of the wild. *Nature*. 563: 27-30. DOI: 10.1038/d41586-018-07183-6.

5 Allan JR. Venter O. Watson JEM. 2017. Temporally inter-comparable maps of terrestrial wilderness and the Last of the Wild. *Scientific Data*. 4: 170187. DOI: 10.1038/sdata.2017.187.

6 Jones KR. Klein CJ. Halpern BS. Venter O. Grantham H. Kuempel CD. *et al*. 2018. The location and protection status of Earth's diminishing marine wilderness. *Current Biology*. 28(15): 2506-2512. DOI: 10.1016/j.cub.2018.06.010.

7 WWF-Canada. 2017. Living Planet Report Canada: A national look at wildlife loss. Currie J. Giles E. Snider J. *World Wildlife Fund Canada*. DOI: 10.13140/RG.2.2.24442.34247.

8 WWF-Canada. 2020. Living Planet Report Canada: Wildlife at Risk. Currie J. Snider J. Giles E. World Wildlife Fund Canada. Toronto, Canada. DOI: 10.13140/RG.2.2.16556.49280.

9 ECCC. 2019. Canadian Environmental Sustainability Indicators: Changes in the status of wildlife species at risk. *Environment and Climate Change Canada*. Gatineau, Quebec. https://www.canada.ca.

10 Ferreira CC. Hossie TJ. Jenkins DA. Wehtje M. Austin CE. Boudreau MR. 2019. The recovery illusion: What is delaying the rescue of imperiled species. *BioScience*. 69(12): 1028-1034. DOI: 10.1093/biosci/biz113.

11 Smart Prosperity Institute. 2018. Species in the balance: Partnering on tools and incentives for recovering Canadian species at risk. McFatridge S. Young T. *Smart Prosperity Institute*. Ottawa, Ontario. https://institute.smartprosperity.ca.

12 Smart Prosperity Institute. 2018. Species in the balance: Partnering on tools and incentives for recovering Canadian species at risk. McFatridge S. Young T. *Smart Prosperity Institute*. Ottawa, Ontario. https://institute.smartprosperity.ca.

13 ECCC. 2018. Horizontal evaluation of the Species at Risk Program. *Environment and Climate Change Canada*. Gatineau, Quebec. http://publications.gc.ca.

14 Smart Prosperity Institute. 2018. Species in the balance: Partnering on tools and incentives for recovering Canadian species at risk. McFatridge S. Young T. *Smart Prosperity Institute*. Ottawa, Ontario. https://institute.smartprosperity.ca.

15 Martin TG. Kehoe L. Mantyka-Pringle C. Chades I. Wilson S. Bloom RG. *et al*. 2018. Prioritizing recovery funding to maximize conservation of endangered species. *Conservation Letters*. 11(6): e12604. DOI: 10.1111/conl.12604.

16 Cardwardine J. Martin TG. Firn J. Reyes RP. Nicol S. Reeson A. *et al*. 2018. Priority threat management for biodiversity conservation: a handbook. *Journal of Applied Ecology*. 56(2): 481-490. DOI: 10.1111/1365-2664.13268.

17 Cardwardine J. Martin TG. Firn J. Reyes RP. Nicol S. Reeson A. *et al*. 2018. Priority threat management for biodiversity conservation: a handbook. *Journal of Applied Ecology*. 56(2): 481-490. DOI: 10.1111/1365-2664.13268.

18 Martin TG. Kehoe L. Mantyka-Pringle C. Chades I. Wilson S. Bloom RG. *et al*. 2018. Prioritizing recovery funding to maximize conservation of endangered species. *Conservation Letters*. 11(6): e12604. DOI: 10.1111/conl.12604.

19 Cardwardine J. Martin TG. Firn J. Reyes RP. Nicol S. Reeson A. *et al*. 2018. Priority threat management for biodiversity conservation: a handbook. *Journal of Applied Ecology*. 56(2): 481-490. DOI: 10.1111/1365-2664.13268.

20 Kehoe L.J. Lund J. Chalifour L. Asadian Y Balke E. Boyd S. *et al*. 2020. Conservation in heavily urbanized biodiverse regions requires urgent management action and attention to governance. *Conservation Science and Practice*. DOI: 10.1111/csp2.310.

21 Martin TG. n.d. Priority threat management. *Martin Conservation Decisions Lab*. https://www.taramartin.org/research.

22 Conservation Measures Partnership. 2013. Open Standards for the Practice of Conservation. Version 3.0. https://cmp-openstandards.org.

23 Conservation Measures Partnership. 2013. Open Standards for the Practice of Conservation. Version 3.0. https://cmp-openstandards.org.

24 ECCC. 2011. Recovery strategies. *Environment and Climate Change Canada*. Gatineau, Quebec. https://wildlife-species.canada.ca.

25 ECCC. 2019. Species at Risk Act: action plants. *Environment and Climate Change Canada*. Gatineau, Quebec. https://www.canada.ca.

26 Smart Prosperity Institute. 2018. Species in the balance: Partnering on tools and incentives for recovering Canadian species at risk. McFatridge S. Young T. *Smart Prosperity Institute*. Ottawa, Ontario. https://institute.smartprosperity.ca.

27 Hebblewhite M. 2017. Billion dollar boreal woodland caribou and the biodiversity impacts of the global oil and gas industry. *Biological Conservation*. 206: 102-111. DOI: 10.1016/j.biocon.2016.12.014.

28 Martin TG. Kehoe L. Mantyka-Pringle C. Chades I. Wilson S. Bloom RG. *et al*. 2018. Prioritizing recovery funding to maximize conservation of endangered species. *Conservation Letters*. 11(6): e12604. DOI: 10.1111/conl.12604.

29 CRI. 2011. The Saint John River: A state of the environment report. *Canadian River Institute*. Fredericton, New Brunswick. https://www.unb.ca.

30 WWF-Canada. 2020. 2020 Watershed Reports: A national reassessment of Canada's freshwater. Paquette C. Hemphill L. Merante A. Hendriks E. *World Wildlife Fund Canada*. Toronto, Canada. http://watershedreports.wwf.ca.

31 CIRNAC. 2019. Oromocto First Nation has room to grow with Addition to Reserve. *Crown-Indigenous Relations and Northern Affairs Canada*. Ottawa, Ontario. https://www.canada.ca.

32 CIRNAC. 2019. Joint statement on negotiations with the Mi'gmaq of New Brunswick. *Crown-Indigenous Relations and Northern Affairs Canada*. Ottawa, Ontario. https://www.canada.ca.

33 DFO. Reconciliation in action: Fisheries agreement reached between Government of Canada and the Elsipogtog and Esgenoôpetitj First Nations. *Fisheries and Oceans Canada*. Ottawa, Ontario. https://www.canada.ca.

34 CBC. 2019. 2 Wolastoqey bands sue federal government over access to snow crab fishery. *CBC News*. Toronto, Ontario. https://www.cbc.ca.

35 ECCC. 2019. Canadian Environmental Sustainability Indicators: Canada's conserved areas. *Environment and Climate Change Canada*. Gatineau, Quebec. https://www.canada.ca.

36 Smart Prosperity Institute. 2018. Species in the balance: Partnering on tools and incentives for recovering Canadian species at risk. McFatridge S. Young T. *Smart Prosperity Institute*. Ottawa, Ontario. https://institute.smartprosperity.ca.

37 East Coast Environmental Law. 2020. Protected on paper only: An evaluation of New Brunswick's legal obligations under the Species at Risk Act. *East Coast Environmental Law*. Halifax, Nova Scotia. https://www.ecelaw.ca.

38 Camaclang AE. Currie J. Giles E. Forbes GJ. Edge CB. Monk WA. *et al*. 2020. Prioritizing threat management across terrestrial and freshwater realms for species conservation and recovery. *Conservation Science and Practice. In Press*.

39 Chadès I. Nicol S. van Leeuwen S. Walters B. Firn J. Reeson A. *et al*. 2015. Benefits of integrating complementarity into priority threat management. *Conservation Biology*. 29: 525-536. DOI: 10.1111/cobi.12413.

40 Firn J. Maggini R. Chadès I. Nicol S. Walters B. Reeson A. *et al*. 2015. Priority threat management of invasive animals to protect biodiversity under climate change. *Global Change Biology*. 21: 3917-3930. DOI: 10.1111/gcb.13034.

41 CRI. 2011. The Saint John River: A state of the environment report. *Canadian River Institute*. Fredericton, New Brunswick. https://www.unb.ca.

42 CBC. 2020. Killed by Liberals in 2014, business property tax cuts resurrected by PCs. *CBC News*. New Brunswick. https://www.cbc.ca.

43 Department of Finance and Treasury Board. 2020. Budget – Creating a culture of action. *Government of New Brunswick*. Fredericton, New Brunswick. https://www2.gnb.ca.

44 NB Power. n.d. Mactaquac Life Achievement Project. *NB Power*. Fredericton, New Brunswick. https://www.nbpower.com.

45 Stantec. 2016. Mactaquac project: Final comparative environmental review (CER) report – summary document. *Stantec*. Fredericton, New Brunswick. https://www.nbpower.com.

46 Clean Water Act. 1990. New Brunswick Regulation 90-80 under the Clean Water Act (O.C. 90-532). *Government of New Brunswick*. Fredericton, New Brunswick. http://laws.gnb.ca.

47 Murphy PNC. Ogilvie J. Connor K. Arp PA. 2007. Mapping wetlands: A comparison of two different approaches for New Brunswick, Canada. *Wetlands*. 27(4): 846-854.

48 DERD. 2019. Investment in conservation. Natural Resources and Energy Development, *Government of New Brunswick*. Fredericton, NB. https://www2.gnb.ca.

49 McMichael A. Scholes R. Hefny M. Pereira E. Palm C. Foale S. 2005. Linking ecosystem services and human well-being. In Capistrano D. Samper K. Cristián L. Marcus J. Raudsepp-Hearne C. Ecosystems and human well-being: multi-scale assessments. *Millennium Ecosystem Assessment*. Washington, DC. https://www.millenniumassessment.org.

50 Adams VM. Iacona GD. Possingham HP. 2019. Weighing the benefits of expanding protected areas versus managing existing ones. *Nature Sustainability*. 2(5): 404-411. DOI: 10.1038/s41893-019-0275-5.

51 Aspinall M., O'Donnell S. Glynn T. Beckley T. 2019. Manufacturing consent for an extractive regime in rural New Brunswick, Canada. *The Journal of Rural and Community Development*. 14(4): 27-49.

52 Nadeau, S. Beckley T. McKendy M. Keess H. 2011. A snapshot of New Brunswick non-industrial forest owners in 2011: Attitudes, behavior, stewardship and future prospects. A study conducted for the Private Forest Task Force. *Province of New Brunswick*. Fredericton, New Brunswick. https://www2.gnb.ca.

53 NRCan. 2019. Forest land ownership. *Natural Resources Canada*. Ottawa, Ontario. https://www.nrcan.gc.ca.

54 Department of Agriculture, Aquaculture and Fisheries. 2020. Farming in New Brunswick… A road map for new entrants – 2020 edition. *Government of New Brunswick*. Fredericton, New Brunswick. https://www2.gnb.ca.

55 Canadian Agricultural Partnership. n.d. Environmentally Sustainable Agriculture. *Government of New Brunswick* and *Government of Canada*. https://www2.gnb.ca.

56 East Coast Environmental Law. 2020. Protected on paper only: An evaluation of New Brunswick's legal obligations under the Species at Risk Act. *East Coast Environmental Law*. Halifax, Nova Scotia. https://www.ecelaw.ca.

Common nighthawk © Shutterstock

A Canada with abundant wildlife, where nature and people thrive.

wwf.ca