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Exploring the implementation of Ontario's biological offsetting process for species at risk

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Abstract

Biodiversity offsetting is a tool to mitigate biodiversity loss by compensating for adverse human impacts on a species or its habitat. However, the effectiveness of offsetting is debated and should be considered a last resort relative to protection or management. We explored the implementation of an offsetting approach in Ontario, Canada, known as the overall benefit permit (OBP). An OBP authorizes an activity that will harm a species at risk of extinction or its habitat, on the condition that actions are taken to achieve an overall benefit (more than no net loss) to the species. We categorized and compared actions across 412 OBPs issued from 2008 to 2023. Of all 264 listed species at risk in Ontario, 22% were represented in OBPs, but 57.4% of permits comprised only 8 species. Actions to achieve overall benefit were primarily targeted to Land/Water Management (48.3%), followed by Species Management (17.8%) and Monitoring (13.8%). Overall benefit criteria were not consistently met across permits, with only half of all permits specifying a timeline for completion. We recommend improving the overall benefit approach by prioritizing actions that can directly increase population resiliency and habitat suitability, inclusion of clear timelines, and compliance monitoring to ensure outcomes are being met.

Key words: biodiversity conservation, biological offsets, Ontario *Endangered Species Act*, overall benefit permit, species at risk

Introduction

Biodiversity offsetting is a conservation tool that aims to compensate for biodiversity lost from human activity by attempting to balance impacts with actions that create an equivalent ("no net loss") or greater ("net gain") amount of biodiversity (Business and Biodiversity Offsets Programme (BBOP) 2012; Schoukens and Cliquet 2016). The stated goal of offsetting is to allow human development to continue within a framework of biodiversity conservation, and this strategy is being increasingly adopted by industries and governments (Maron et al. 2016, 2020). Many countries have implemented mitigation policies intended to achieve "no net loss", but the efficacy of these mitigation strategies is unclear (e.g., Bull and Strange 2018).

Ideally, offsetting should be considered a measure of last resort within the mitigation hierarchy (Arlidge et al. 2018), or used to complement mitigation measures that avoid or reduce human impacts on biodiversity (BBOP 2012; Maron et al. 2016). However, the ethics of trading biodiversity, the associated social challenges, and the uncertain effectiveness of offsetting actions remain contentious (Maron et al. 2016; Pope et al. 2021). In practice, offsetting approaches are often associated with ambiguous biodiversity or species recovery targets, and uncertain or vague timelines for project completion or biodiversity gains (Maron et al. 2016; Bull and Brownlie 2017). Evaluating the effectiveness of offsetting actions is challenging, as the necessary data for evaluation are not available for most projects (Quétier and Lavorel 2011; Bull et al. 2013; Gelcich et al. 2017; Algera et al. 2022; Binley et al. 2025). Where post-implementation evaluation is possible, "no net loss" is not always achieved (Quigley and Harper 2006), or, if offsetting programs do achieve "no net loss", the broader ecological system beyond the scope of the offsetting program may still experience biodiversity loss (May et al. 2017).

In Canada, the responsibility for biodiversity conservation is shared among federal, provincial, municipal, and Indigenous governments (Bergman et al. 2020; Kraus et al. 2021; Gordon et al. 2024). The Canadian *Species At Risk Act* (*Species at Risk Act, s.c. 2002, c. 29*) mandates protection of species at risk (SAR; also known as threatened, imperiled, or endangered species) on federal lands. Until mid-2025, the protection and recovery of SAR and their habitats in the Province of Ontario were legislated by the provincial *Endangered Species Act* (ESA) (Ontario Endangered Species Act 2007*a*, c.6, s.17(2)(c); Zagorski et al. 2019). Under the ESA, the extra-governmental Committee on the Status of Species at Risk in Ontario (COSSARO) assessed the conservation statuses of wild species using assessment criteria similar to those used by the International Union for the Conservation of Nature (IUCN). Species

assessed as at-risk by COSSARO were automatically listed on Ontario's Species at Risk list (SARO; Ontario Endangered Species Act 2007*a*, O. Reg. 230/08). Ontario's ESA was initially lauded as one of the strongest pieces of conservation legislation in Canada (Nixon et al. 2012; Olive and Penton 2018), although iterative legislative revisions substantially weakened the Act (e.g., shifting thresholds for species assessment and permanent exemptions for forestry operations; Bergman et al. 2020; Bethlenfalvy and Olive 2021).

Despite ongoing weakening of the Ontario ESA (e.g., Bergmann et al. 2020; Ray et al. 2021), it is a critical tool to protect SAR and their habitats on provincial and private lands. However, on 5 June 2025, the Ontario Government enacted the *Protect Ontario by Unleashing our Economy Act, 2025*, which repealed the ESA, and proposed replacement with a future *Species Conservation Act* (SCA). Permits issued under the ESA will continue to apply, but permits for future activities will be issued under the SCA when it comes into effect. As biodiversity in Ontario continues to decline, particularly in the most heavily developed southern regions of the Province (Coristine and Kerr 2011; Ray et al. 2021; Proctor et al. 2022), we sought to inform future implementation of the SCA by examining how permits were issued under the now-repealed ESA. In particular, we focused on the "overall benefit permit" (OBP), an off-setting approach in the ESA that sought to balance species conservation with increasing demands for development (Ontario Endangered Species Act 2007*a*, c.6, s.17(2)(c)).

The Ontario ESA prohibited harm to SAR and damage or destruction of their habitat, and the protection and recovery of SAR and their habitats was stated as a key aspect in conserving Ontario's biodiversity (Ontario Endangered Species Act 2007*b*, c.6, s.9(1)/10(1)). An OBP authorized a proponent (i.e., a person, company, or organization) to perform activities that contravened these sections (e.g., clear SAR trees to construct a condominium, or harm SAR fish habitat during road or bridge work), as long as an overall benefit was achieved for the impacted species (Ontario Endangered Species Act 2007*a*, c.6, s.17(2)(c)). This approach required the proponent to search available data and conduct surveys to identify SAR and their habitat in an area that would be affected, and to undertake actions to minimize adverse effects to achieve overall benefit ("more than no net loss") for those species (Ontario Endangered Species Act 2007*a*, c.6, s.17(2)(c); BBOP 2012). The approval process for an OBP required the proponent to follow a mitigation hierarchy: (1) consider reasonable alternatives to the proposed project; (2) implement reasonable steps to minimize adverse effects on the species of interest; and (3) outline actions to achieve an overall benefit to the species of interest within a reasonable time frame (Ontario Endangered Species Act 2007*a*, c.6, s.17(2)(c)). Actions that provided an overall benefit, defined by the Province, included increasing the number of wild reproducing individuals, increasing species distributions within natural ranges, increasing species population resiliency, reducing population declines, or increasing the quantity or quality of habitat for a species (Ontario Endangered Species Act 2007*a*, c.6, s.17(2)(c)). Once the requirements of the application were approved by the Ministry of Natural Resources, the Minister issued a permit.

In this study, we aggregated publicly available permits and characterized implementation of the overall benefit framework under the ESA. Our objectives were to examine temporal, taxonomic, and spatial trends in OBPs that were issued under the ESA. Using a qualitative approach, we sought to highlight areas in which approved actions were likely to achieve overall benefit, if performed as stated in the permit. We also considered areas in which implementation (i.e., actions in the permits) could be better aligned with the stated intent of the ESA. Ideally, we would evaluate the actual, realized impact of the offsetting required in the permits, but the data required to do so are not available. Nevertheless, inclusion of appropriate offsetting methods in the permits is required to eventually achieve overall benefit, so examining permit content provides insight into potential outcomes. To supplement our main objectives, we used the five most frequently represented taxa as focal species to further investigate whether the approved actions were likely to meet the province's criteria and achieve an overall benefit to the target species. Although our study focused on a single province in Canada, the findings are broadly relevant to other jurisdictions that are considering or using biodiversity offsets. We discuss how our results can inform future implementation of the SCA or other offsetting strategies.

Methods

To create a database of actions approved in OBPs, we accessed permits available through the open-access Environmental Registry of Ontario (ERO): (https://ero.ontario.ca/; ERO 2023*a*). We used the search phrase "*overall benefit*" to pull all OBPs posted, from the first permits issued in 2008 until the search date (30 September 2023). This search resulted in 441 available permits, with 138 from the active library and 303 from the archive. We excluded 29 documents that were not OBPs, resulting in $n = 412$ permits for analysis. Of these permits, 33 were withdrawn by the proponent or the issuing ministry prior to implementation. These were cases where the applicant withdrew the application, it was determined that no permit was actually required, or it was determined that a different permit was required instead. We retained these withdrawn permits in our analysis, because they still contained approved actions intended for implementation of the OBP framework.

We established a standardized set of coding rules (Supplementary Table S1) to maintain consistency when extracting information from OBPs into a database. To create these coding rules, seven co-authors extracted the same information from an initial test set of permits. Co-authors initially scored this test set of permits and compared results to finalize a standardized format for entering information in the database, and to ensure consistency. Permits applying to multiple species were given an individual entry for each species, allowing us to quantify the frequency of occurrence of each species in the database, along with the actions approved for each species.

Temporal, taxonomic, and spatial trends

We counted the number of permits issued each year (2008–2023) and the number of SAR in each major taxonomic group to examine temporal trends in permits. Although we could not directly assess the impacts of changes in government on the overall benefit process, we plotted provincial election years to visualize potential trends of changing governments in relation to possible changes to the ESA legislation and the OBP process. We also compared the number of SAR for which permits were issued with the total number of SAR in each major taxonomic group on the SARO list (https://www.ontario.ca/page/species-risk-ontario; Ontario Endangered Species Act 2007*a*, O. Reg. 230/08) to determine the proportion of SAR represented in OBPs.

To visualize spatial trends in OBPs, we created a kernel density plot from permit locations. Location details varied by OBP, with some providing exact addresses and others providing imprecise location descriptions such as rural roads or townships. Where precise locations were not specified in the permit, we identified the approximate location based on the broad description provided (accurate to within 10 km). Lastly, to account for locations where the ESA did not apply, we placed a layer containing the Managed Forest Zone (Ministry of Natural Resources and Forestry (MNRF) 2021), an area spanning much of central and northern Ontario that is managed for forestry and has been exempt from the Ontario ESA since 2020 (Lysyk 2021).

Categorizing actions used to achieve overall benefit

We extracted all actions to achieve overall benefit for species described in each OBP. Here, we describe the standardized classification of actions, which are also summarized in Table 1. To group actions in OBPs within an established conservation classification scheme, we used two schemes outlined by the IUCN: (1) the Conservation Action Classification Scheme (Version 2.0), for Conservation Actions, defined as "interventions that need to be undertaken to help improve the conservation status of [a] taxon" (IUCN 2012*a*); and (2) the Research Needed Classification Scheme (Version 2.0), for Research Actions, which are needed to fill knowledge gaps for a given taxon (IUCN 2012*b*). We used the two schemes together because OBPs sometimes included both conservation and research actions. Standardizing classification of actions allowed comparison across permits and species within our study and enabled us to present our findings within a widely used framework that can enable future comparisons with conservation activities in other jurisdictions (Salafsky et al. 2008).

The IUCN framework for both schemes organizes actions under three possible levels of classification. For instance, within the IUCN's Level-1 category of Land/Water Management, there is a Level-2 category of Habitat and Natural Process Restoration, which is defined as "enhancing degraded or restoring missing habitats and ecosystem functions". Similarly, within the Level-1 category of Species Management, Level 2 categories include "Species Recovery" (IUCN 2012*a*). Some Level-2 categories are not subdivided into a third level, so we used only the first two levels (i.e., Level-1 and Level-2) to categorize the actions we extracted from the OBPs. For consistency, one co-author (JPK) categorized all OBP actions across all permits. For example, permit ERO 012-8980 required "creating five (5) turtle nesting habitats as identified and determined by the assessment study and in consultation with [Ministry of Natural Resources and Forestry]" (ERO 2023*b*). This example was categorized as an action to "create/improve habitat" under the Habitat and Natural Process Restoration category within Land/Water Management. We summed the number of times a given action (and its Level-1 or -2 categories) appeared in a permit and compared this value across species and total number of permits.

Implementation of the overall benefit approach using focal species

We chose the four most frequently represented species in OBPs as focal species: butternut (*Juglans cinerea*; $n = 106$ occurrences across 412 permits), redside dace (*Clinostomus elongatus*; $n = 88$), Blanding's turtle (*Emydoidea blandingii*; $n = 45$), and bobolink (*Dolichonyx oryzivorus*; $n = 44$). As a fifth focal group, we considered the four SAR bat species represented in OBPs as a single group, which was also frequently represented ($n = 22$). This group included little brown myotis (*Myotis lucifugus*), northern myotis (*Myotis septentrionalis*), eastern small-footed myotis (*Myotis leibii*), and tricolored bat (*Perimyotis subflavus*). Bat SAR were considered as one focal group in this review because bat-related permits either did not differentiate actions for individual species, or assigned actions for all included species (e.g., "Enhance habitat for all 3 [bat] species by planting a mixture of trees and shrubs"; ERO 12-8196).

We discussed whether OBP actions were likely to meet the province's criteria to achieve overall benefit to the target species using a qualitative approach and drawing on published studies evaluating the effectiveness of the prescribed actions. To define overall benefit, we drew directly from the criteria as stated by the province: "whether an action could increase the number of wild reproducing individuals, increase species distributions within natural ranges, increase species population resiliency, reduce population declines, or increase the quantity or quality of habitat for a species" (https://www.ontario.ca/page/species-risk-overall-benefit-permits; Ontario Endangered Species Act 2007*a*, c.6, s.17(2)(c)). For the five focal species, we qualitatively compared the actions with the described criteria to achieve overall benefit to identify where these aligned, and where they did not.

Reasonable time frames

One criterion outlined in the ESA to achieve overall benefit that we could quantify was the requirement to complete actions within a "reasonable time frame". We quantified the proportion of permits that specified a time frame for actions to take place, and permits that did not. For example, permits with wording such as "Monitoring the use of this Overall Benefit Area habitat by Eastern Whip-poor-will for five years within one year of the permit being approved" (ERO

Table 1. Conservation Action Classifications (IUCN 2012*a*, 2012*b*) used to categorize overall benefit actions described in OBPs issued under the Ontario *Endangered Species Act* from 2007, when the first permits were issued under the Act, to 30 September 2023 ($n = 412$).

Level 1 category (IUCN)	Level 2 category (IUCN)	Action category (OBP)
Conservation Actions (75.9%)		
Education & awareness (8.2%)	Awareness & communications (7.8%)	Educational outreach (4.3%)
		Post signage of SAR information in area (3.0%)
		Post-warning signage notifying individuals of SAR presence (0.6%)
	Training (0.4%)	Training staff on SAR (i.e., handling, removal, identification) (0.4%)
Land/water management (48.3%)	Habitat & natural process restoration (42.2%)	Addition of riparian vegetation (2.5%)
		Bank stabilization (2.3%)
		Consider species in land use management (0.2%)
		Construct a fish ladder (0.2%)
		Create shelter (0.3%)
		Create/improve habitat (18.1%)
		Creating high-quality habitat (i.e., rules in place to ensure SAR success) (1.3%)
		Culvert replacement/upgrade (1.3%)
		Enhance/establish movement corridors (3.8%)
		Improve water quality (3.3%)
		Install basking logs (0.2%)
		Minimize work during key seasons (i.e., nesting, breeding, hibernating, etc.) (0.8%)
		Planting native plant species (1.1%)
		Planting/tending companion seedlings (2.9%)
		Prescribed burn/canopy opening measures (0.1%)
		Reduce human entry to/use of habitat (0.8%)
		Remove stream-altering debris (0.2%)
		Create/improve general bat habitat (1.5%)
		Create/improve foraging habitat (0.4%)
		Create/improve roosting habitat (0.6%)
		Create/improve hibernaculum habitat (0.2%)
		Create/improve reproduction habitat (0.2%)
		Improve habitat connectivity (0.1%)
	Invasive/problematic species control (2.4%)	Fencing to prevent herbivore feeding on seedlings (0.1%)
		Install protective barrier fencing upstream (0.1%)
		Minimize impact/presence of invasive species (1.4%)
		Removal of non-SAR species from area (0.9%)
	Site/area management (3.7%)	Implement traffic calming measures (0.1%)
		Incorporate road design features that discourage use of road shoulders for nesting sites (0.1%)
		Install exclusion fencing (1.9%)
		Install silt fence to funnel movement (0.1%)
		Prevent pollution of pond habitats (0.1%)
		Reduce nutrient loading levels (0.8%)
		Retention of acceptable habitat (0.7%)
Land/water protection (1.6%)	Resource & habitat protection (1.6%)	Obtain environmental protection designation for habitat (1.6%)
Species management (17.8%)	Ex situ conservation (14.2%)	Archiving individuals (not determined as resistant) (0.6%)
		Archiving resistant trees (3.0%)
		Assisted dispersal of seeds from mature plants (0.1%)
		Clonal propagation (0.1%)
		Distributing seeds to be planted (0.2%)

Table 1. (*concluded*).

Level 1 category (IUCN)	Level 2 category (IUCN)	Action category (OBP)
		Grafting/planting scions (2.0%)
		Planting/tending seedlings (5.9%)
		Replacing lost transplanted individuals (1.1%)
		Seed collection (1.2%)
	Species reintroduction (0.1%)	Turtle reintroduction (0.1%)
	Species recovery (3.6%)	Construct nesting structures (0.4%)
		Install nest protection boxes (0.4%)
		Transplant colony to new location (0.1%)
		Transplant retainable individuals (0.3%)
		Create/improve artificial roosts (2.4%)
		Create/improve artificial hibernacula (0.1%)
Research Actions (24.1%)		
Conservation planning (0.4%)	Species action/recovery plan (0.4%)	Detailed caribou transfer strategy that reaches minimum requirements (0.1%)
		Feasibility assessment (recovery through population augmentation) (0.1%)
		Oversee species recovery initiatives (0.3%)
Monitoring (13.8%)	Habitat trends (7.3%)	Monitoring created/improved habitat (6.9%)
		Monitoring noise levels near habitat (0.1%)
		Monitoring artificial roost types (0.3%)
		Monitoring artificial hibernacula (0.1%)
	Population trends (6.4%)	Determine SAR distribution in area (0.3%)
		Monitor nesting activity (0.3%)
		Monitoring of newly planted individuals (2.5%)
		Monitoring of relocated individuals (0.7%)
		Survey SAR presence/habitat use (2.3%)
		Monitoring use of artificial roosts (0.3%)
Research (9.9%)	Conservation actions (6.0%)	Expand archiving efforts/capacity (0.2%)
		Monitoring/reporting on mitigation measures (5.4%)
		Research artificial roost types (0.3%)
		Research monitoring methods (0.1%)
	Life history & ecology (3.0%)	Genetic variation research (0.1%)
		Research bat white-nose syndrome (0.3%)
		Life history-related research (3.5%)

Note: Percentages refer to the representation of each action or category out of all 412 OBPs. SAR = species at risk. IUCN, International Union for the Conservation of Nature; OBP, overall benefit permit.

011-6238; ERO 2023*b*) met this criterion. Permits that omitted a time frame or provided a vague time frame (e.g., "Monitor and report on the number of adult Bobolinks and fledged young using the replacement habitat and the rehabilitated habitat"; ERO 011-6276; ERO 2023*b*) did not meet this criterion.

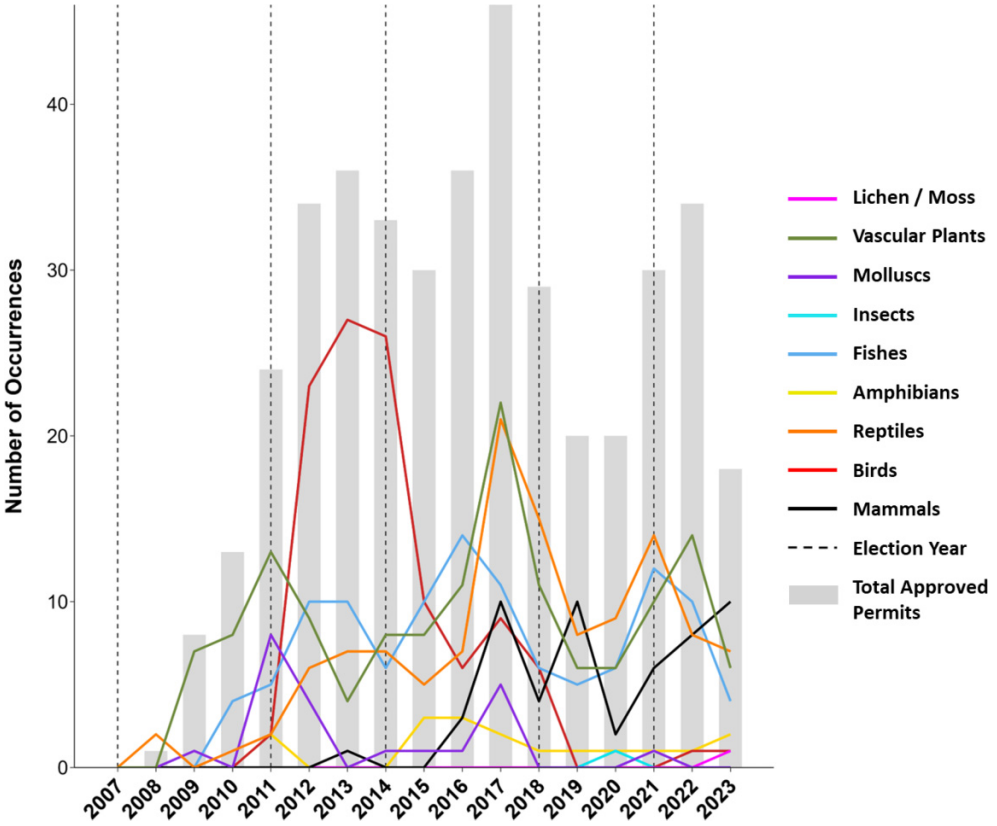
Results

Temporal, taxonomic, and spatial trends

The 412 permits assessed included actions to protect 58 species of SAR (22% of the species listed under the ESA at the time of analysis). The annual number of issued OBPs increased from 2008 to 2017, coinciding with the tenure of a provincial Liberal government, decreased from 2018 to 2020, coinciding with the election of a provincial Conservative government, and then increased again. Permits issued for birds peaked in 2012 and 2013. The total number of permits issued varied over the years (Fig. 1).

There were 582 species occurrences across permits, which included vascular plants (n = 143; 24.6% of species occurrences), reptiles (n = 119; 20.4%), fishes (n = 113; 19.4%), birds (n = 112; 19.2%), mammals (n = 54; 9.3%), molluscs (n = 22; 3.8%), amphibians (n = 17; 2.9%), lichens and mosses (n = 1; 0.2%), and insects (n = 1; 0.2%; Fig. 2). The most frequently represented species in OBPs were butternut (n = 106; 18.2% of overall species occurrences; 74.1% of vascular plant occurrences), redside dace (n = 88; 15.1% overall; 77.9% of fishes), Blanding's turtle (n = 45; 7.7% overall; 37.8% of reptiles), and bobolink (n = 44; 7.6% overall; 39.3% of birds). Mammals were represented almost exclusively by four at-risk bat species: little brown myotis (n = 22), northern myotis (n = 14), eastern small-footed myotis (n = 8), and tricolored bat (n = 7). When

Fig. 1. Number of overall benefit permits (OBPs) approved annually (grey-shaded bars) under Ontario's *Endangered Species Act* from 2007, when the first permits were issued under the Act, to September 2023 (n = 412). Coloured lines denote yearly occurrences of species from each taxonomic group in OBPs. The vertical dashed lines indicate Ontario provincial election years.



considered as a group, the four SAR bat species accounted for 94.4% of all mammal occurrences and 8.8% of all species occurrences (Fig. 3).

OBPs were issued most frequently in southern Ontario, especially within 50 km of Toronto (n = 95), Ottawa (n = 53), Hamilton (n = 49), Kitchener (n = 28), and Windsor (n = 25). Within the Managed Forest Zone, where forestry activities were exempt from the ESA, only 13 OBPs were issued north of Sudbury (i.e., the southern limit of northern Ontario, at approx. 46.5°N). Only a single OBP was issued north of Red Lake (approx. 51.0°N; Fig. 4). In the northern Ontario region, activities requiring permits included urban infrastructural development, and rural activities related to resource extraction and facilities like mines, solar energy plants, or implementing transmission lines.

Actions used to achieve overall benefit

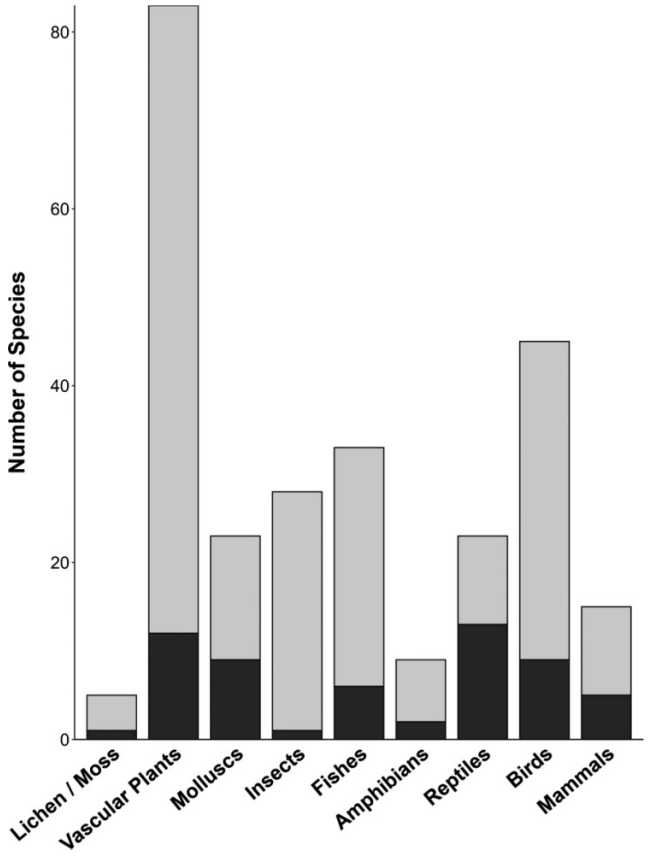
The 412 OBPs listed a total of 1787 actions to achieve overall benefit. Of these actions, 75.9% were Conservation Actions and 24.1% were Research Actions (Table 1). Insects were the only group for which all actions were Conservation Actions (Fig. 5), but insects were only represented in a single permit focused on mottled duskywing (*Erynnis martialis*).

Within Conservation Actions, the most frequently approved were Land/Water Management Actions (48.3% of all actions), which primarily consisted of Habitat and Natural Process Restoration Actions (87.3% of Land/Water Management Actions; Table 1). Land/Water Management Actions were described in OBPs for eight of the nine taxonomic groups (all except lichen/moss; Fig. 5). Permits for insects were exclusively related to Land/Water Management Actions. Species Management Actions constituted 17.8% of actions and were represented across five taxonomic groups, but most frequently for plants and mammals (Fig. 5). Species Recovery Actions constituted 20.1% of all Species Management Actions and were almost exclusively related to bats (e.g., install nest protection boxes or create/improve protection boxes). The remaining Conservation Actions included Education and Awareness (8.2% of all actions) and Land/Water Protection (1.6%). For Research Actions, most overall benefit actions were categorized as Monitoring (13.8%) or Research (9.9%), while Conservation Planning made up 0.4% of all actions across permits.

Focal species

Conservation and Research Actions varied among the five focal groups, reflecting the different requirements of the SAR species. The most common actions were creating/improving habitat for Blanding's turtle (62.2%), redside dace (83%), and bobolink (79.5%), planting/tending seedlings for butternut (72.6%), and creating/improving artificial roosts for bats (81.8%; Table 2). Actions to "[increase] the quantity or quality of habitat for a species" (i.e., Land/Water Management Ac-

Fig. 2. Total number of species at risk (SAR) listed under Ontario's *Endangered Species Act* (Ontario Endangered Species Act 2007*b*) by taxonomic group (grey bar), and the number of those SAR that are represented in overall benefit permits (dark inset bars).



tions) were the primary approved action for all focal species, excluding butternut. Actions such as educational outreach (2.3%–5.7%) and posting signage of SAR information in the area (0%–13.6%) were among the least frequently used, particularly for bobolink and butternut. No Species Management Actions appeared in OBPs for redside dace or bobolink, and only one Species Management Action was described for Blanding's turtle (installing nest protection boxes, 8.9% of actions for this species; Table 2).

Reasonable time frames

A key criterion for overall benefit was that the benefit to the target species was achieved within a reasonable time frame. Of the 412 unique permits, 194 (47.0%) provided some timeline to complete actions to achieve overall benefit, although four of these were withdrawn before implementation. Some provided specific timelines to completion, such as "within 5 years", but others were more vague. For example, some actions were set to be achieved "within a reasonable time". Others provided dates for specific phases of projects (e.g., "working during the appropriate timing window for redside dace [July 1 to September 15]; ERO 019-5531), but not a timeline to the actions benefitting the species. The other 218 permits (53.0%) did not state timelines for completion, and 7 of these were withdrawn before implementation.

Discussion

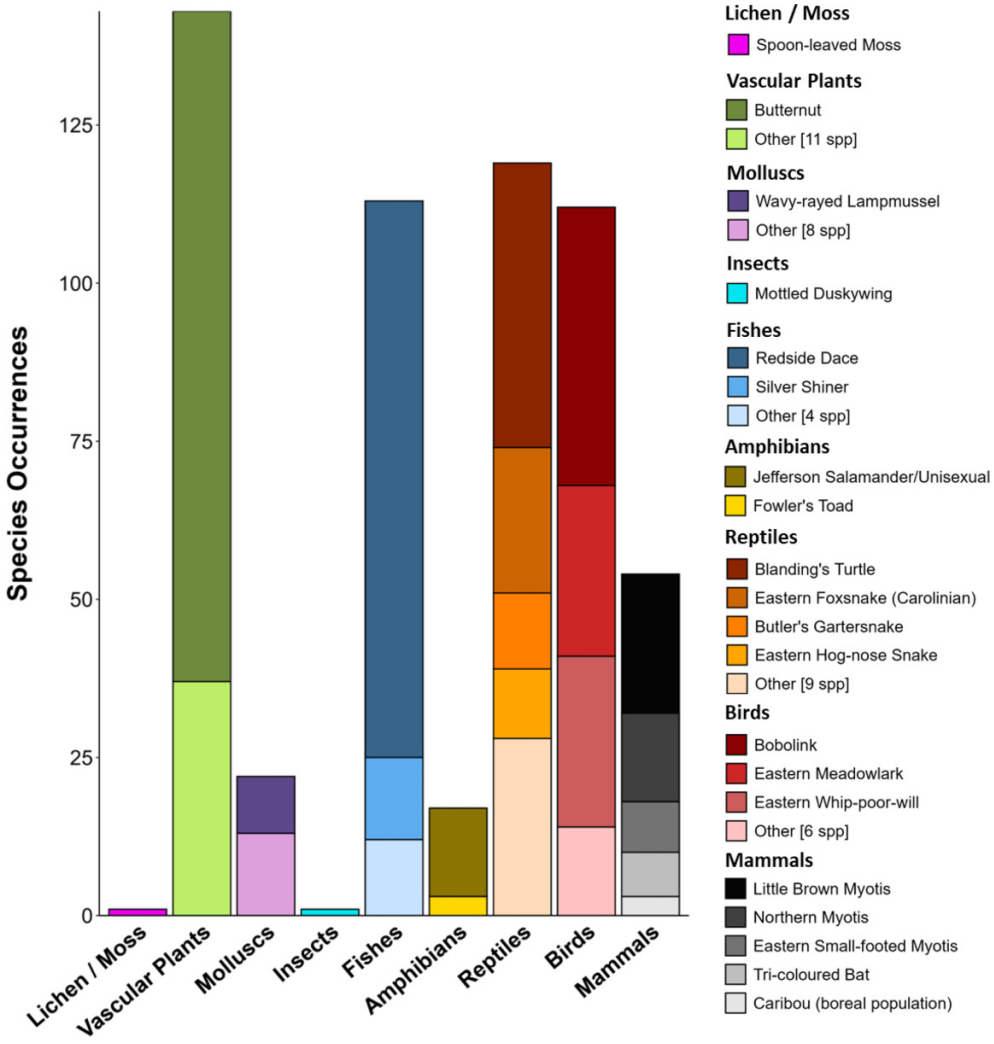
Our study highlights an uneven spatiotemporal representation of SAR in permits issued under the Ontario ESA, along with temporal and taxonomic trends that may partly reflect shifting species designations and political cycles. We found that actions related to habitat restoration were the most frequently approved in permits, but we are concerned that the effectiveness of such actions could be impacted by time lags between restoration and habitat uptake by target species, lack of connectivity among habitat patches, and cumulative threats such as climate change (Bull and Brownlie 2017). Overall, it was unclear whether the actions approved in OBPs would be sufficient to achieve net gains for SAR, as many permits lacked Species Management Actions and most permits did not include explicit timelines for completion. There are many recognized pitfalls in biological offsetting strategies (Bull et al. 2013; Maron et al. 2016; Gelcich et al. 2017; Bidaud et al. 2018), but there are real opportunities for improved implementation in Ontario's approach, which we have tried to uncover by examining the implementation of OBPs under Ontario's now-repealed ESA.

Temporal, taxonomic, and spatial trends

The general increase in the number of OBPs issued per year from 2008 to 2017 coincided with the tenure of the Liberal provincial government that passed Ontario's Endangered Species Act (2007*a*). The approximately 50% decrease in yearly OBPs in 2018 coincided with the election of a Conservative provincial government. In 2019, this Conservative government amended Ontario's ESA to reduce the power of the Act, including exemptions for forestry operations and some other development activities (Bergman et al. 2020; Bethanflavy and Olive 2021; Ray et al. 2021). Subsequent legislation further weakened protection for SAR, including amendments under Bill 108 (More Homes, More Choice Act 2019, c. 9, s. 16.1), which allowed developers to pay into a conservation fund in lieu of applying on-the-ground mitigation actions during activities in SAR habitat (Bergman et al. 2020; Bethlenfalvy and Olive 2021). Assessing the disbursement and conservation impact of these funds is beyond the scope of this study, but others have noted that there is uncertainty as to how these funds are being used, and which species and habitats are benefitting from them (Bergman et al. 2020).

Approximately 22% of Ontario SAR were included in OBPs, suggesting that development that requires offsetting is mostly occurring in the critical habitats of these particular SAR. However, a few taxa (butternut, redside dace, Blanding's turtle, bobolink, and "bats") accounted for the majority of species occurrences in OBPs (57.4%; Fig. 3). Species within a taxonomic group were not evenly represented (e.g., vascular plants had a low species representation, but Butternut was the most frequently represented species across permits). We also noted that although most permits were issued for southern Ontario, where SAR richness is high and many SAR co-occur (McCune et al. 2019), many permits considered only a single species. It is possible that SAR with lower detection probabilities are more likely to be overlooked during the OBP application process, reflecting the general challenges of pro-

Fig. 3. Species occurrences in the 412 overall benefit permits issued under Ontario's *Endangered Species Act* (Ontario Endangered Species Act 2007*b*) from 2008 to 30 September 2023, grouped by taxon. Species occurrences refers to the number of times the species appeared in any permit.



tecting species with low detection rates (Garrard et al. 2015). Understanding and accounting for how detection probability varies for SARO-listed species, affecting their access to legal protection, could help achieve "more than no net loss" in the implementation of OBPs.

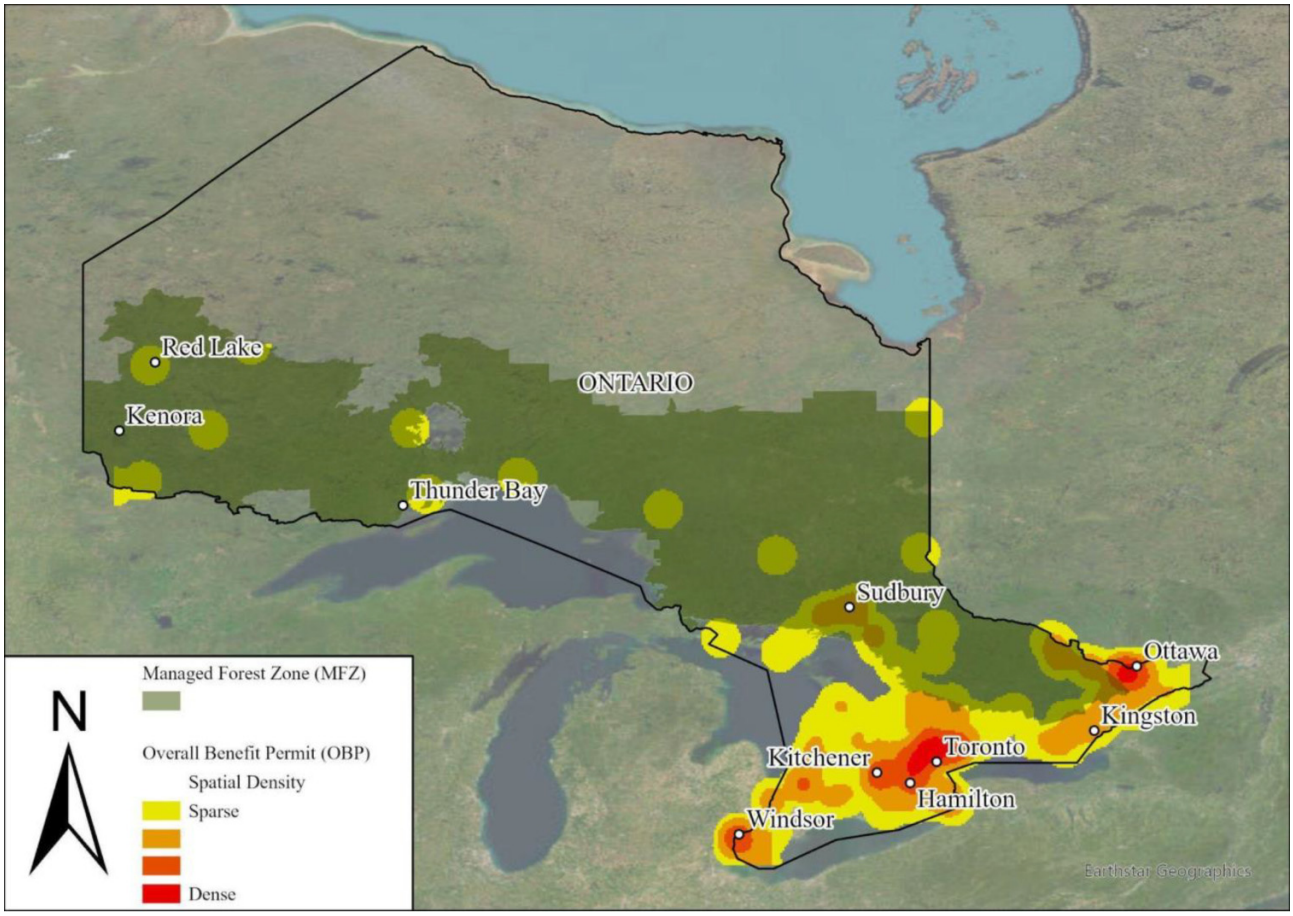
Taxonomic trends in OBPs may also reflect shifts in the provincial conservation status of species. For example, COSSARO assessed the eastern whip-poor-will (*Antrostomus vociferus*), bobolink, and eastern meadowlark (*Sturnella magna*) as Threatened in 2009, 2010, and 2011, respectively (McCracken et al. 2013; Ministry of the Environment, Conservation and Parks (MECP) 2019*a*). These assessments were followed by an increase in permit approvals for those species in 2012–2013 (whip-poor-will represent 24.1% of all bird OBPs, bobolink 39.3%, and meadowlark 24.1%; Fig. 1). Similar peaks in OBPs for Blanding's turtle and butternut followed their COSSARO assessments and subsequent addition to the ESA (Poisson and Ursic 2013; MECP 2019*b*; Fig. 1).

As expected, most permits were issued near major metropolitan areas in southern Ontario (Fig. 4), which are some of the most densely populated and rapidly developing areas in Canada (Coristine and Kerr 2011; Kraus and Hebb 2020; Proctor et al. 2022). Fewer OBPs were issued in northern Ontario, which may partially reflect limited monitoring in hard-to-reach locations or lower SAR richness (McCune et al. 2019), and therefore lower probability of an activity overlapping with SAR habitat. The concentration of OBPs in southern Ontario may also reflect the blanket exemption from the ESA for forest management operations across the Managed Forest Zone (Lysyk 2021).

Actions used to achieve overall benefit using focal taxa

To achieve overall benefit, the Government of Ontario stated that actions must include more than minimizing adverse effects on species or habitats. Examples included increasing numbers of wild reproducing individuals, reducing population declines, etc., and these outcomes were intended to occur within reasonable time frames (Ontario Endangered

Fig. 4. Kernel density plot for the 412 overall benefit permits (OBPs) issued under the Ontario *Endangered Species Act* from 2008 to 30 September 2023, from sparse in yellow to denser concentrations from orange to red and overlaid by the Managed Forest Zone (MNRF 2021) in semi-transparent green. Cities that overlap with OBP hotspots are labelled. Black outline indicates provincial borders. All OBPs are issued within the borders of Ontario; yellow markers expanding past provincial borders reflect density. Basemap: ESRI World Imagery (~1 m).



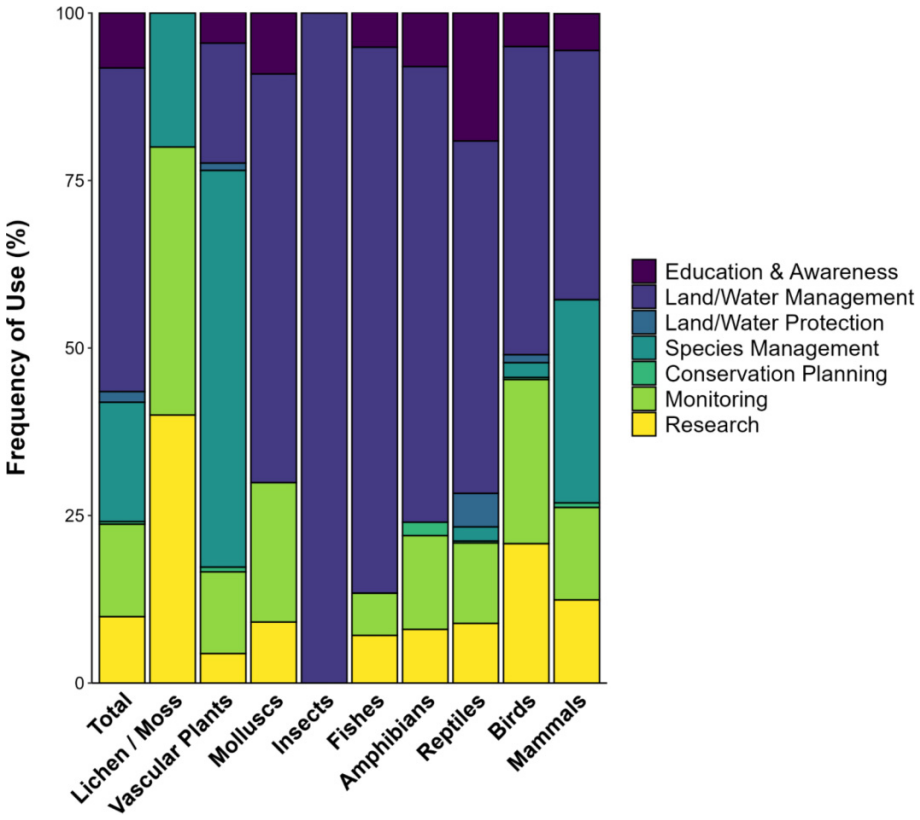
Species Act 2007*a*, c.6, s.17(2)(c)). It was not possible to rigorously evaluate actual, realized impact of the actions in the OBPs, but we took a qualitative approach to consider whether actions listed in the focal taxa's permits aligned with the stated criteria of the overall benefit process (i.e., were likely to achieve overall benefit).

We found that adherence to the Province's criteria was inconsistent among focal taxa and across permits in general. For example, most actions for butternut directly supported population augmentation and resiliency by planting, tending, and reintroducing new individuals. Butternut recovery and conservation techniques have been implemented since the early 1990s to target canker disease, the primary threat to butternut (Woeste et al. 2009; Morin et al. 2018), and are likely to contribute to overall benefit for the species. In contrast, few actions listed for the other four focal species were likely to directly slow declines, increase species' distributions, abundance, or resiliency, or increase habitat quantity or quality substantially, relative to the harm permitted by the OBP. These other actions could minimize adverse effects of the proposed activity on the affected species, but they are unlikely to achieve overall benefit.

A few permits contained a Species Management Action for Blanding's turtle ("install nest protection boxes"; 8.9% of Blanding's turtle OBPs; Table 2). Nest protection boxes can reduce nest predation, but population-level effects of nest caging are typically very small (Riley and Litzgus 2013; Henning and Hinz 2016). More direct approaches such as head-starting turtles (i.e., rearing hatchlings to a larger size before release) can bolster population recruitment as long as other threats are simultaneously mitigated (Buhlmann et al. 2015; Carstairs et al. 2019; Thompson et al. 2020; Wijewardena et al. 2023). Improving juvenile recruitment must coincide with improving adult survival (Henning and Hinz 2016), and several actions could reduce road mortality of adult turtles (e.g., installation of exclusion fencing; 48.9% of Blanding's turtle OBPs; Table 2). There are elements of the current approach that may increase population growth for Blanding's turtles, and focusing on these elements in future actions could more explicitly meet the criteria for overall benefit.

Species Management Actions for bats were largely related to "creating/improving artificial roosts" (81.8% of all bat permits; Table 2), which is categorized as Species Management

Fig. 5. Proportional representation of Conservation Actions for 9 taxonomic groups, in 412 overall benefit permits issued under the Ontario *Endangered Species Act* from 2007, when the first permits were issued under the Act, until 30 September 2023. Overall benefit actions are categorized following the International Union for the Conservation of Nature Level 1 Conservation Actions Classification Scheme (IUCN 2012*a*, 2012*b*; Table 1).



under the IUCN classification schemes, but is arguably habitat creation rather than species management. True "species management" actions for bats, such as ex situ management, are difficult to achieve and unlikely to have meaningful population-level impacts (e.g., white-nose syndrome management; Davy and Whitear 2016; Paterson et al. 2021). Artificial bat roosts, which include bat boxes or bat houses, do provide appropriate roosting habitat for some bat species. However, they do not inherently increase population resiliency or effectively mitigate the broader impacts of habitat loss (Rueegger et al. 2018; Blasco-Arostegui et al. 2021; Crawford and O'Keefe 2021; Lausen et al. 2022; Matus-Olivares et al. 2025). As artificial roosts alone are not a one-to-one replacement for loss of natural roosting habitat (Rueegger et al. 2018), Land/Water Management Actions can be implemented around these roosts to better replace roosting and foraging habitat lost to development. Of 21 bat-related permits that required building of artificial roosts, 16 permits also included Land/Water Management Actions. Increased pairing of these actions can better support bat conservation and recovery.

No Species Management Actions were included in OBPs for redside dace or bobolink. For redside dace, this may reflect limited options. For example, its reintroduction (a potential Species Management Action) was only identified as a priority conservation action in Canada in 2019, and methods for its implementation are being tested (Turko et al. 2021). Almost all conservation strategies for bobolink are related to adapting the timing of agricultural practices to improving breeding success, as bobolink often nest in agricultural fields (Diemer and Nocera 2016). Modified harvest timing can improve nest success and minimize adverse effects by reducing population declines (Brown and Nocera 2017). However, without strategies to actively increase populations, such actions are unlikely to achieve overall benefit for the species.

The primary threats to bobolink, Blanding's turtle, and redside dace are related to habitat loss and degradation due to urbanization and agriculture (Diemer and Nocera 2016; Turko et al. 2021; Meng and Chow-Fraser 2023). Actions to achieve overall benefit for these species were focused on Land/Water Management, and aimed at improving, creating, or restoring habitat. These actions address the overall benefit criteria of increasing the quantity or quality of habitat for a species and could help support species' populations. However, there are often substantial time lags between habitat creation or restoration and uptake by the target species (Bull and Brownlie 2017; Kraus et al. 2021; Pope et al. 2021). Restored habitats are unlikely to replicate the quality of the intact habitat, thereby making the achievement of an overall benefit unlikely, especially when multiple threats exist (Bull and Brownlie 2017; Kraus et al. 2021). If the created or restored habitat is not connected by suitable habitat to occurrences of the

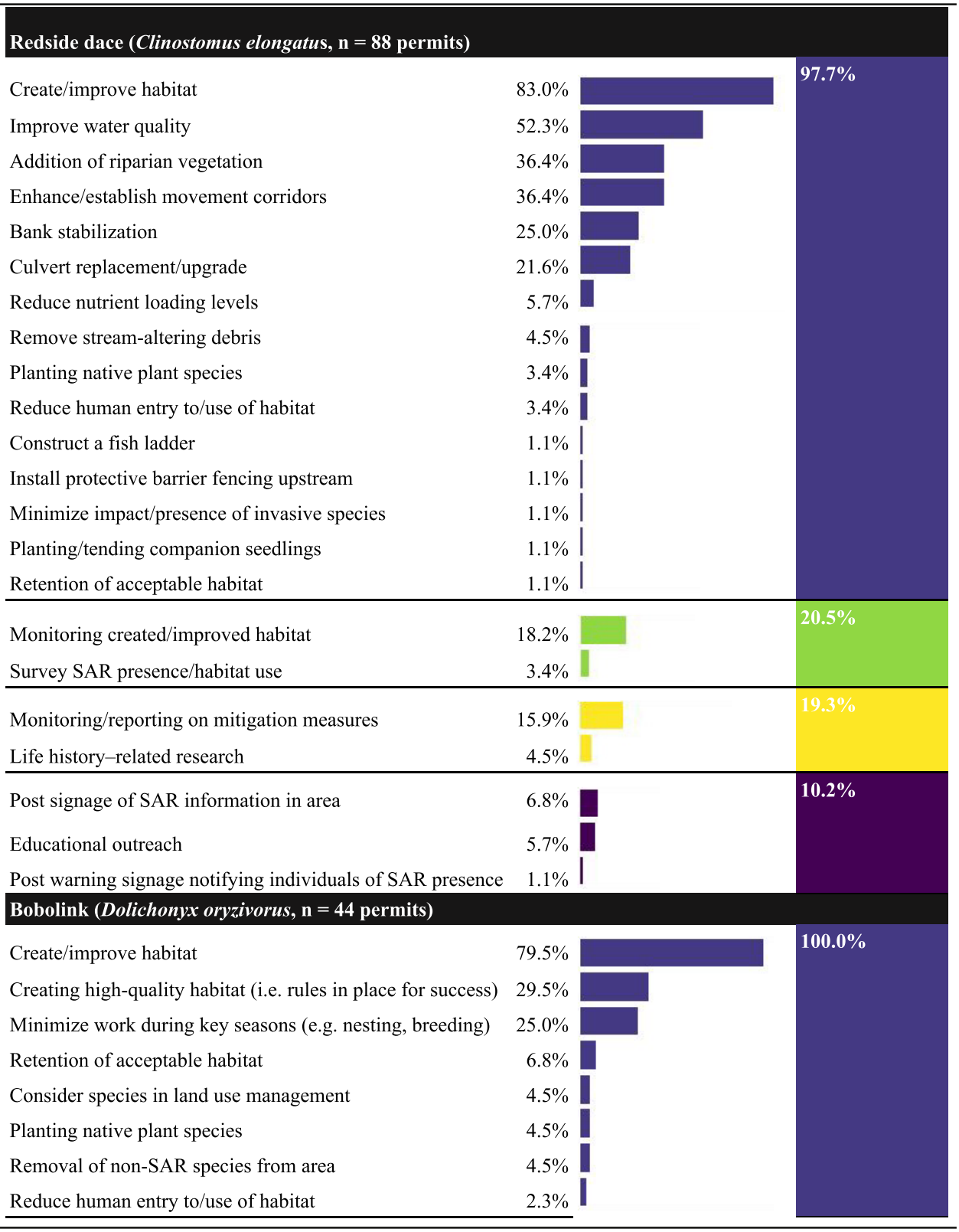
Table 2. Frequency of overall benefit actions (and their International Union for the Conservation of Nature Level 1 categories) present in overall benefit permits issued from 2007 to September 2023 ($n = 412$) under the Ontario *Endangered Species Act*, for butternut (*Juglans cinerea*), redside dace (*Clinostomus elongatus*), bobolink (*Dolichonyx oryzivorus*), Blanding's turtle (*Emydoidea blandingii*), and four bat species (little brown myotis (*Myotis lucifugus*), northern myotis (*Myotis septentrionalis*), eastern small-footed myotis (*Myotis leibii*), and tricolored bat (*Perimyotis subflavus*)).

Specific Action	Frequency of Use	Action Category
Butternut (*Juglans cinerea*, n = 106 permits)		
Planting/tending seedlings	72.6%	98.1%
Archiving resistant trees	50.9%	
Grafting/planting scions	33.0%	
Seed collection	17.0%	
Replacing lost transplanted individuals	13.2%	
Archiving individuals (not determined as resistant)	9.4%	
Distributing seeds to be planted	3.8%	
Transplant retainable individuals	2.8%	
Clonal propagation	0.9%	
Planting/tending companion seedlings	42.5%	42.5%
Create/improve habitat	0.9%	
Monitoring of newly planted individuals	34.0%	34.9%6
Survey SAR presence/habitat use	0.9%	
Expand archiving efforts/capacity	3.8%	4.7%
Life history–related research	0.9%	
Monitoring/reporting on mitigation measures	0.9%	
Oversee species recovery initiatives	2.8%	2.8%
Educational outreach	2.8%	2.8%
Obtain environmental protection designation for habitat	0.9%	0.9%

target species, it may also be inaccessible to them. A 2021 provincial audit discussed a case where 9.6 ha of Blanding's turtle habitat were destroyed or damaged, and actions included constructing a 0.49 ha pond (Lysyk 2021). At the time of the audit, no turtles had inhabited the constructed pond in the 2 years following the project (Lysyk 2021). Furthermore, for eight OBPs related to redside dace issued between 2019 and 2021, actions allowed for substantially less restored or replaced habitat than was destroyed or damaged (Lysyk 2021). Net habitat loss seems unlikely to achieve overall benefit, although we recognize that empirical evidence of action outcomes would be required to evaluate actual, realized outcomes of these or other OBPs.

Another key criterion of overall benefit is that actions are achieved within a "reasonable time frame" (Ontario Endangered Species Act 2007*a*, c.6, s.17(2)(c)). The terminology of a "reasonable time frame", while vague, allows for assessment on a contextual basis that could cater to the specific needs of the SAR or the project on a permit-to-permit basis. Though we could not objectively assess if the time frames for each action in each permit were "reasonable", we found that fewer than half (47%) of all issued OBPs included an explicit timeline for completion. Incorporating clear timelines into future permits can allow for evaluation of project outcomes (ten Kate and Crowe 2014; Maron et al. 2016; Bull and Brownlie 2017) and help to achieve either "no net loss" or "net gain".

Table 2. (*continued*).



Evaluating the effectiveness of actions through measurable outcomes over a clear time frame is critical to create better frameworks for biological offsetting (Pickett et al. 2013; Curran 2018).

Actions described by the OBP should also match the type of impact of the development that is being conducted. We recognize that in some cases, development may be unavoidable (e.g., reinforcing an existing bridge). However, in new devel-

Table 2. (*continued*).

Monitoring created/improved habitat	54.5%	65.9%
Survey SAR presence/habitat use	9.1%	
Monitor nesting activity	4.5%	
Monitoring/reporting on mitigation measures	25.0%	38.6%
Life history–related research	18.2%	
Educational outreach	2.3%	4.6%
Post signage of SAR information in area	2.3%	
Blanding's turtle (*Emydoidea blandingii*, n = 45 permits)		
Create/improve habitat	62.2%	91.1%
Install exclusion fencing	48.9%	
Enhance/establish movement corridors	28.9%	
Planting native plant species	11.1%	
Culvert replacement/upgrade	6.7%	
Install basking logs	6.7%	
Minimize impact/presence of invasive species	6.7%	
Reduce human entry to/use of habitat	4.4%	
Retention of acceptable habitat	4.4%	
Improve water quality	2.2%	
Incorporate features that discourage use of roads to nest	2.2%	
Minimize work during key seasons (e.g. nesting, breeding)	2.2%	
Monitoring created/improved habitat	24.4%	28.9%
Survey SAR presence/habitat use	6.7%	
Monitoring/reporting on mitigation measures	20.0%	28.9%
Life history–related research	8.9%	
Post signage of SAR information in area	13.3%	22.2%
Training staff on SAR (i.e. handling, removal, identification)	6.7%	
Educational outreach	4.4%	
Post warning signage notifying individuals of SAR presence	4.4%	
Install nest protection boxes	8.9%	8.9%
Obtain environmental protection designation for habitat	6.7%	6.7%
Oversee species recovery initiatives	2.2%	2.2%

opments, actions on the OBP should be accountable in reducing species impacts (e.g., choosing a different site). The overall benefit framework in Ontario from 2008 to 2023 emphasized enabling human activities and development, rather than protection of biodiversity and SAR, with very few permits rejected or revised (Lysyk 2021). Our understanding of the outcomes of conservation actions for SAR is limited (Binley et al. 2025). Additionally, our understanding of offsets for the protection of species is still flawed, and in the case of individual species, oftentimes unknown (e.g., Brudvig and Catano 2024).

Table 2. (*concluded*).

Bats (four species – see figure caption, n = 22 permits)		
Create/improve artificial roosts	81.8%	81.8%
Create/improve artificial hibernacula	4.5%	
Create/improve general bat habitat	54.5%	77.3%
Create/improve foraging habitat	18.2%	
Create/improve roosting habitat	18.2%	
Create/improve hibernaculum habitat	4.5%	
Create/improve reproduction habitat	4.5%	
Improve habitat connectivity	4.5%	
Monitoring/reporting on mitigation measures	13.6%	36.4%
Research artificial roost types	13.6%	
Research white-nose syndrome	9.1%	
Research monitoring methods	4.5%	
Monitoring artificial roost types	9.1%	22.7%
Monitoring use of artificial roosts	9.1%	
Survey SAR presence/habitat use	9.1%	
Monitoring artificial hibernacula	4.5%	
Post signage of SAR information in area	13.6%	18.2%
Educational outreach	4.5%	

Note: SAR, species at risk.

For developments that impact SAR, we argue that this uncertainty should be accounted for by placing the onus on the proponent to show how their methods are able to achieve overall benefit for the species, and to prepare alternative methods should this goal not be reached. Below, we provide recommendations for OBPs that can achieve tangible net gains, not just "no net loss" or "like-for-like".

Recommendations

Continued application of an overall benefit approach could support future SAR recovery in Ontario by focusing on evidence-informed actions and effective, on-the-ground implementation. While offsetting approaches such as Ontario's have limitations (Maron et al. 2016; Bull and Brownlie 2017), they can support species persistence on the landscape when implemented thoughtfully. From this perspective, we propose four ways to improve the overall benefit approaches we examined.

Our first recommendation is for Land/Water Management Actions to be paired with direct Species Management Actions wherever possible. Increasing habitat suitability in conjunction with increasing species' population resiliency and viability is critical to SAR recovery, particularly for populations persisting in created or restored habitats (Browne and Hecnar 2007). We acknowledge that including more Species Management Actions in permits requires lists of evidence-based actions that can support population growth across various SAR, and these are not always available. Thus, evaluation of the effectiveness of Species Management Actions should be a research priority for conservation scientists who seek to inform policy (Binley et al. 2025). We also recognize that research actions alone are unlikely to achieve species recovery, but can often provide benefits to offsetting as an alternate type of investment or fill knowledge gaps required to select effective actions (ten Kate et al. 2004; Buxton et al. 2020). Inclusion of scientific studies (i.e., Research Actions) in OBPs requires research that will provide a tangible benefit to the target species (Ministry of Natural Resources and Forestry (MNRF) 2017). This guidance was a particular strength of the process used under the ESA and can facilitate adaptive management of the overall benefit framework as new research becomes available.

Our second recommendation is to ensure inclusion of specific time frames. The ability of an action to meet a policy objective depends on a clear project scope and a clear time

frame for completion (Possingham et al. 2001; ten Kate and Crowe 2014). However, more than half of the issued OBPs did not provide clear time frames. This challenge is not unique to OBPs and also occurs in Canadian recovery strategies (Kraus et al. 2021). Improved research and monitoring activities provide opportunities to better define what should be considered a "reasonable" time frame to target the specific needs of each species. As such, these time frames should be more consistently and robustly included in future offsetting practices to allow for contextually based actions and better evaluation of impacts.

Our third recommendation for improving the overall benefit permitting process is to take a more precautionary approach to harming SAR and their habitats. In the mitigation hierarchy, offsetting should be considered a last resort or only considered when other options are exhausted (Arlidge et al. 2018; Poulton and Ray 2023). Additionally, the effectiveness of many offsetting strategies considered for Ontario OBPs has not been confirmed. Given the uncertainty of offsetting techniques, it is essential to consider strengthening the steps of the mitigation hierarchy, by focusing on mitigation and minimization when no proven offsetting measures are available (e.g., Poulton and Ray 2023). Shifting focus toward mitigation and minimization would require a pathway to deny permit applications that do not include proven offset techniques that actually benefit SAR, and we recognize that this is a question of political will, and may be difficult in practice. There is currently no guidance on what would constitute sufficient cause to deny an application (Lysyk 2021), so it is unclear whether the criteria for overall benefit are requirements, or simply guidelines. The goal of the OBP process is to facilitate development that does not compromise SAR recovery, so denying applications is obviously not a desired outcome. Nevertheless, the lack of benchmarks for satisfactory permit conditions leaves the requirements vague for both the proponent and the regulatory agencies.

Our fourth and final recommendation is to explicitly integrate evaluation into the overall benefit process, to enable an adaptive management approach to permitting. As of 2021, the Ontario Ministry of Environment, Conservation, and Parks does not have strategies or measures to assess the effectiveness of OBPs, so the actual, realized outcomes of the process are unclear (Lysyk 2021). Integrating well-designed monitoring of SAR responses to overall benefit actions would allow evaluation of the effectiveness and inform future actions for improved implementation of OBPs to achieve intended net gains. Evaluating the robustness of OBP actions and their ability to achieve net gains with empirical evidence can quantify the effectiveness of actions, which was beyond the scope of this study.

The new SCA in Ontario is expected to remove permit requirements for development in SAR habitat, relying on proponents to follow a set of general guidelines and self-regulate. It also dilutes the definition of habitat to the point where protected habitats represent only a part of what the species require to complete their life processes. In our study, we identified areas in which the overall benefit framework could be improved, and areas in which implementation of the ESA was unlikely to achieve its stated goals. Our intention is to support future improvements to species conservation in Ontario and more broadly. The ESA enabled species conservation in Ontario that would not have been possible otherwise, and the decision to repeal it directly threatens the shared natural heritage of the people of Ontario.

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Data availability

All relevant data are within the paper, and all overall benefit permits used in this study are available on the Environmental Registry of Ontario: https://ero.ontario.ca/.

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The authors have declared that no competing interests exist.

Supplementary material

Supplementary data are available with the article at https://doi.org/10.1139/facets-2025-0215.

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