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### Publication Date

2025

### DOI

10.1111/conl.13072


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## PERSPECTIVE OPEN ACCESS

# Co-Benefits From Species-Level Conservation Contribute to Multilateral Environmental Agreement Targets

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**Received:** 28 May 2024 | **Revised:** 4 November 2024 | **Accepted:** 8 November 2024

**Funding:** The authors received no specific funding for this work.

**Keywords:** bat conservation | cave ecosystems | ecological countermeasures | nature's contributions to people | spillover prevention | sustainable development

## ABSTRACT

Conservation investments do not operate within a zero-sum paradigm, but instead provide opportunities for co-benefits across sustainable development and conservation goals. Recognizing the interconnectedness of conservation efforts within socioenvironmental systems can amplify support for conservation actions, ultimately creating additional co-benefits across the social, ecological, and economic sectors. As an ecologically diverse taxonomic group with broad conservation needs, we explore how conserving bats contributes to both biodiversity and society's economic and social needs. We align bat conservation goals with Global Biodiversity Framework targets and explore their contribution to the United Nations Sustainable Development Goals. The benefits of targeted bat conservation actions extend beyond species-level conservation goals and the preservation of bat-derived ecosystem services, encompassing broader contributions to global sustainability goals. Our findings underscore the potential for conservation investments to generate positive outcomes across multiple sectors, fostering sustainability and resilience within socioenvironmental systems.

## 1 | Introduction

Limited resources available to fund action toward society's numerous development and conservation goals can lead to conflict when investment is seen as a zero-sum game in which supporting one set of goals detracts from the other (Chen and Pensini 2024; Baker et al. 2017; Galvani et al. 2016). The misperception that investing in conservation detracts from society's other goals is particularly pervasive. However, the targets of conservation efforts are integral components of socioenvironmental systems in which the fates of populations, species, ecosystems, and global systems that include human society are intertwined. Consequently, implementing conservation actions targeting any biological level can yield multiple co-benefits to

all parts of these systems, including human society. Identifying and articulating these conservation co-benefits for economic growth, public health, education, and culture can amplify and sustain support for conservation actions while also potentially creating additional co-benefits that align with society's development goals. Biodiversity serves as the central focus of several multilateral environmental agreements (MEAs), which delineate targets towards globally shared conservation goals (Ferraro and Failler 2024). Given that species are the currency of biodiversity, species-level conservation provides an effective way to make clear, measurable contributions to established shared goals. Here, we map how species-level conservation actions focused on bats align with the Global Biodiversity Framework (GBF) targets (CBD 2022) and contribute to the United Nations Sustainable

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Development Goals (UNSDGs) (UN 2015) in the form of co-benefits.

Bat conservation initiatives are typically designed to protect bat species and their habitats, with any additional benefits resulting from these initiatives considered positive externalities of bat conservation goals. These externalities, instead, can be intentionally managed as co-benefits spanning ecological, social, economic, and health sectors. For instance, protecting bats and their habitats supports ecosystem service provision (Ramírez-Fráncel et al. 2022; Kunz et al. 2011) and reduces contact and conflict between bats and humans, thereby reducing the risk of pathogen spillover events (Plowright et al. 2024). Conservation initiatives often foster partnerships with local stakeholders, leading to knowledge transfer, increased technical capacity, and mobilization of financial resources (Pretty and Smith 2004). Explicitly identifying how bat conservation efforts contribute to socioenvironmental systems could enhance the success of conservation initiatives and render conservation actions more effective at supporting society's economic and social needs.

Bats are an ecologically diverse taxonomic group composed of over 1470 recognized species (Simmons and Cirranello 2024) that have varying conservation needs, yet all require access to high-quality resources to meet their needs during foraging, roosting, commuting, and for some species, migrating (Frick et al. 2024; Frick, Kingston, and Flanders 2020). Of the 1390 bat species currently assessed by the International Union for Conservation of Nature (IUCN), 35% are ranked as vulnerable, endangered, critically endangered, or data-deficient. Of the species assessed, 77% have unknown or declining population trends driven by habitat loss, climate change, invasive species and disease, wind turbine collisions, pollution, and hunting, among other threats (Frick, Kingston, and Flanders 2020; IUCN 2023). Meeting the conservation needs of bats through targeted threat reduction actions or broad-scale habitat protection and restoration efforts confers an umbrella species-type of protection to the ecosystems that bats inhabit and the species they co-occur with, ultimately extending these contributions to people who interact with bats and share their ecosystems (Plowright et al. 2024, IUCN SSC 2014).

Bats provide benefits to people through their contribution to three main categories of ecosystem services (Kachler et al. 2023). Regulating services result from bats supporting healthy ecosystem functioning and enhancing social and economic well-being through processes such as pest consumption, pollination, seed dispersal, and nutrient cycling (Ramírez-Fráncel et al. 2022; Tuneu-Corral et al. 2023). Material services provided by bats include products such as guano and meat. Guano can be used as an agricultural fertilizer, while bat meat is consumed in some regions as a protein source when access to other sources is limited or as a luxury food (Sakoui et al. 2020; Latinne et al. 2020; Mildenstein, Tanshi, and Racey 2016). However, unsustainable guano harvesting can disrupt bat colonies and increase the risk of pathogen spillover, and hunting bats for consumption poses significant threats to several bat species and can also lead to pathogen transmission (Osofsky et al. 2023). Nonmaterial services contribute to human well-being in the form of nature enjoyment, which can also be monetized, for example, with bat-emergence tourism (Osofsky et al. 2023; Bagstad and Wiederholt 2013).

Bat conservation initiatives can yield additional co-benefits for people through a broad range of actions that manage bat-human contact, coordinate societal change, and foster understanding and awareness of bats. These benefits are especially relevant to local communities that live near bats. Often, identifying measures that increase safety for bats can have a positive impact on public health, such as raising awareness about how extracting guano sustainably can reduce human exposure to pathogens (IUCN SSC 2014; Mildenstein, Tanshi, and Racey 2016). Effective bat conservation programs often engage with community members, facilitating skills transfer and work experience (Frick et al. 2024). Protecting bat-foraging habitats can increase ecosystem resilience, directly impacting local economic opportunities and well-being, and minimize risk for future pathogen transmission (Plowright et al. 2024). For example, sustainable agricultural practices that protect agave flowers for nectarivorous bats conserve the genetic diversity and survival of agaves, reduce erosion and inefficient water use, and promote sustainability within the agave industry (Lear et al. 2024).

The economic, social, and environmental benefits stemming from healthy bat populations and the actions used to protect them already make meaningful contributions to MEAs that address environmental challenges while contributing to sustainable development. Our goal is to delineate how bat conservation contributes to global biodiversity and sustainability efforts, thereby increasing support for bats and our shared socioenvironmental systems. Thus, we draw from both the GBF and the UNSDGs to measure bat conservation's impact on these systems by using goals, targets, and language already resonating with stakeholders across global, national, and community-level scales. Specifically, we examine how bat ecosystem services and conservation actions align with the GBF and contribute to UNSDG targets.

## 2 | Mapping the Connectivity Between Bat Conservation, GBF Targets, and UNSDGs Targets

Mapping the connectivity between bat conservation, the GBF targets, and the UNSDG targets can help identify how conservation efforts contribute to broader sustainability goals. The GBF includes 23 specific targets developed to transform society's relationship with biodiversity by drawing from UNSDG targets related to ending poverty, hunger, and inequity, protecting the world's natural capital, and fostering health, peace, education, and technological innovation (GBF Section A.3). Similarly, the UNSDGs include 17 goals that broadly address society's sustainable development, addressing food security, public health, education, equity, governance, and biodiversity, with 169 specific targets contributing to these goals.

We defined four comprehensive bat conservation goals aimed at protecting bats and their habitats (Supporting Information, Table S1). These goals encompass protecting bat populations, reducing anthropogenic threats to bats, strengthening research and technical capacity for bat conservation, and raising awareness of the conservation importance of bats (Table 1).

To represent these goals and illustrate their alignment with GBF targets, we used five types of ecosystem services derived from bats and 36 examples of bat conservation actions (Supporting

**TABLE 1** | Goals and targets of bat conservation efforts. Targets are representative of the type of conservation actions implemented under each goal. Table S2 outlines the ecosystem services that result from achieving the goal of “Protect bat populations.” Table S3 outlines examples of bat conservation actions grouped under the goals of “Reduce anthropogenic threats to bat populations,” “Strengthen research and technical capacity for bat conservation,” and “Raise awareness on conservation importance of bats.”

Bat conservation goal	Bat conservation targets
Protect bat populations	<ul style="list-style-type: none"> <li>• Protect bat species to promote healthy populations and prevent extinctions</li> <li>• Ensure provision of ecosystem services provided by bats</li> </ul>
Reduce anthropogenic threats to bat populations	<ul style="list-style-type: none"> <li>• Reduce and mitigate the impacts of land use change on bat populations and their habitats</li> <li>• Mitigate the impacts of climate change on the foraging and roosting habitats of bat populations</li> <li>• Reduce and mitigate the impacts of wind energy development on bat populations</li> <li>• Prevent mortality caused by infection with an introduced and invasive fungus (<i>Pseudogymnoascus destructans</i>) that causes white-nose syndrome</li> <li>• Reduce impacts of bat consumption and trade on bat populations</li> <li>• Prevent persecution of bat populations due to fear of disease, myths, and crop predation</li> <li>• Prevent disturbance of bat roosting habitat caused by hunting, persecution, mining, guano harvesting, and unsustainable cave tourism</li> <li>• Prevent the introduction of and mitigate the impact of invasive species that threaten bat populations or their habitats</li> </ul>
Strengthen research and technical capacity for bat conservation.	<ul style="list-style-type: none"> <li>• Improve and strengthen the transfer of technical knowledge, resources, and conservation leadership in communities and regions with high levels of interactions with bats as well as those with the potential to benefit from bat-derived ecosystem services.</li> <li>• Increase funding for community-led conservation efforts.</li> <li>• Reduce knowledge gaps to inform listing and protection of data-deficient and threatened species.</li> <li>• Monitor bat populations to establish baselines and reduce knowledge gaps.</li> </ul>
Raise awareness on the conservation importance of bats	<ul style="list-style-type: none"> <li>• Increase stakeholder engagement and understanding of the ecological, social, and economic importance of conserving bats and their habitats</li> </ul>

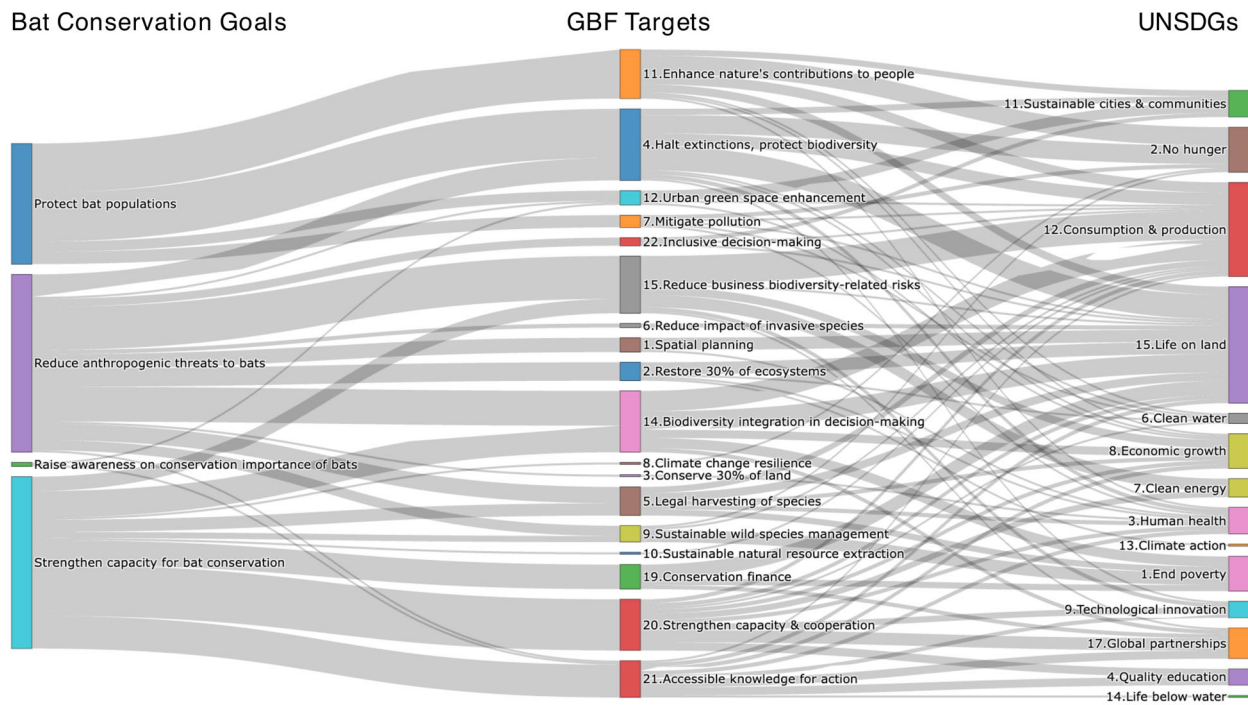
Information, Tables S2 and S3). While protecting bat populations is a broad goal, we assume that the outcomes of this goal ensure the provision of ecosystem services derived from bats (Table S2). Bat conservation actions were compiled by Bat Conservation International experts based on past, present, or prospective projects as representative of actions that are implementable by conservation organizations as part of nature-based solutions. Although this list is not comprehensive, it provides a conservative representation of how bat conservation could contribute to MEA targets (Table S2 and S3). We defined co-benefits as the contributions to specific UNSDG targets that result from ecosystem services and bat conservation actions (Table S2 and S3).

To ensure effective biodiversity conservation strategies, it is essential to measure the outcomes of actions and progress toward meeting targets. As of March 2024, the GBF is still developing indicators for use at national levels and at more localized levels of action. The UNSDGs have clear target-specific indicators, but these indicators are not relevant to assessing bat conservation's impact on targets. Here, we identified alternative indicators relevant to the scale of bat conservation that can be used to

assess how bat conservation actions contribute to UNSDG targets (Tables S2 and S3).

The bat conservation actions and ecosystem services we identified contribute to at least one GBF target and one UNSDG target, enabling us to map pathways that illustrate how bat conservation aligns with both frameworks (Figure 1). Ensuring the provision of ecosystem services derived from bats through the protection of bat populations directly aligns with GBF targets 4, 7, 11, and 12, which emphasize protecting biodiversity, reducing pollution, restoring, maintaining, and enhancing nature's contributions to people, and enhancing green spaces for people and biodiversity (Figure 1). These ecosystem services further contribute to 12 UNSDG targets focused on reducing hunger, improving human well-being, promoting sustainable communities, and protecting biodiversity (Figure 1; Table S2).

Bat conservation actions representing the goals of reducing threats, strengthening capacity, and raising conservation awareness align with 17 GBF targets categorized under the GBF's three overarching themes: reducing threats to biodiversity, meeting



**FIGURE 1** | Pathways by which bat conservation actions and ecosystem services grouped within four comprehensive bat conservation goals align with targets from both the Global Biodiversity Framework (GBF) and the United Nations Sustainable Development Goals. Pathways represent five ecosystem services derived from bats and 36 examples of bat conservation actions. The GBF target names are summarized for clarity.

people's needs through sustainable use and benefit-sharing, and tools and solutions for implementation and mainstreaming. These bat conservation actions could generate co-benefits that contribute to 46 targets spanning 14 UNSDGs (Figure 1; Table S3). Specifically, reducing anthropogenic threats to bats could contribute to targets addressing improved human health and sanitation (UNSDGs 2, 3, 6), economic growth (UNSDG 1, 4, 8, 9), sustainable communities, consumption, and production (UNSDGs 11, 12), climate change mitigation (UNSDG 7, 13), and biodiversity protection (UNSDGs 14, 15). Similarly, strengthening research and technical capacity for bat conservation could contribute to targets focused on improving human health and sanitation (UNSDGs 2, 3, 6), economic growth (UNSDG 1, 4, 8, 9), climate change mitigation (UNSDG 7), sustainable consumption and production (UNSDG 12), biodiversity protection (UNSDG 15), and global partnerships (UNSDG 17). Finally, raising awareness of the conservation importance of bats could contribute to targets centered on promoting sustainable communities, consumption, and production (UNSDGs 11, 12).

### 3 | Application to Special Areas of Bat Conservation

Mapping the connectivity between bat conservation goals, biodiversity targets, and sustainability targets allows a more concrete understanding of consistent relationships and processes that occur within socioenvironmental systems, including bats, people, and ecosystems (Figure 1). By focusing on specific species, habitats, or resources used by bats, conservation initiatives can

contribute to a consistent set of targets. Conservation managers can leverage this mapping to identify collaboration opportunities, leading to shared resources, skills, and knowledge. Cave ecosystems and bat-foraging habitats are examples of habitats for which bat conservation is highly dependent on the outcomes of interactions with people. Initiatives focusing on these systems, particularly those fostering collaborations across sectors, can explicitly identify targets in their project design and facilitate beneficial conservation outcomes supporting economic and social needs. We illustrate this connectivity by outlining relevant GBF and UNSDG targets for cave ecosystems (Box 1) and bat-foraging habitats (Box 2).

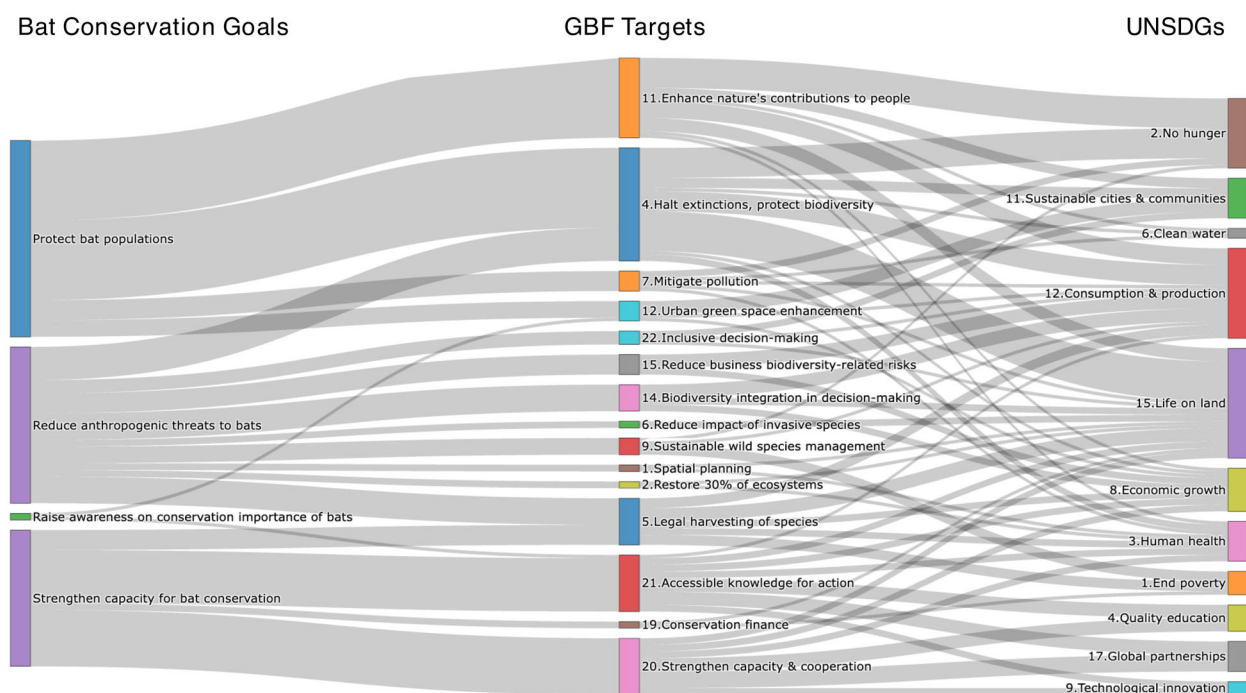
### 4 | Harnessing Co-Benefits to Offset Costs

Far from being at odds, the protection of biodiversity and the achievement of sustainable development objectives can be harmoniously aligned, and indeed, protecting biodiversity creates added value for diverse societal goals. Yet, there are some contexts in which conflict with other conservation or sustainable development objectives appears to occur. Balancing these potentially conflicting goals and outcomes is feasible, and identifying the co-benefits of conservation actions offers valuable perspective when these situations arise. For example, while slowing climate change and mitigating biodiversity loss are internationally recognized conservation goals (CBD 2022; UN 2015), bat collisions with wind energy turbines cause hundreds of thousands of bat fatalities globally each year and cannot be ignored (Voigt et al. 2024). Working with the wind energy industry and its financial lenders

Box 1: Cave ecosystems

As critical roosting habitat for 40% of bat species, caves are important targets for many bat conservation initiatives (Frick, Kingston, and Flanders 2020). Protecting cave bats aligns with at least 15 GBF targets and contributes to at least 36 UNSDG targets focused on improving human well-being (UNSDGs 1, 2, 3, 4, 6), economic growth (UNSDG 8), technological innovation (UNSDG 9), sustainable consumption and production (UNSDG 11, 12), biodiversity protection (UNSDG 15), and international partnerships (UNSDG 17) (Figure Box 1A; Table S2).

The benefits of protecting caves go beyond protecting bats and other species that depend on cave ecosystems (GBF 1, 4; UNSDG 15.5) (Figure Box 1B). Cave bats can enhance local agricultural productivity by reducing crop damage and pesticide use, and their guano is a natural source of fertilizer (GBF 5, 9, 11; UNSDG 2.3, 2.4). Caves offer economic potential through sustainable guano harvesting and ecotourism opportunities (GBF 5, 9; UNSDG 1.4, 12.2), which can lead to tourism-related job creation (GBF 11, 14; UNSDG 8.9). However, raising awareness among local communities on safe and sustainable guano harvesting and ecotourism practices is essential for preventing disturbance of cave-roosting bats and reducing opportunities for pathogen spillover (GBF 4, 20; UNSDG 3.3, 3.d, 12.8, 12.b). Efforts to reduce hunting or poaching of cave bat species for food or trade are effective when collaborating with communities to find alternative sources of meat and income (GBF 5, 9; UNSDG 15.7, 15.c). These initiatives promote economic growth while decoupling from environmental degradation (GBF 5, 9; UNSDG 1.a, 8.4).

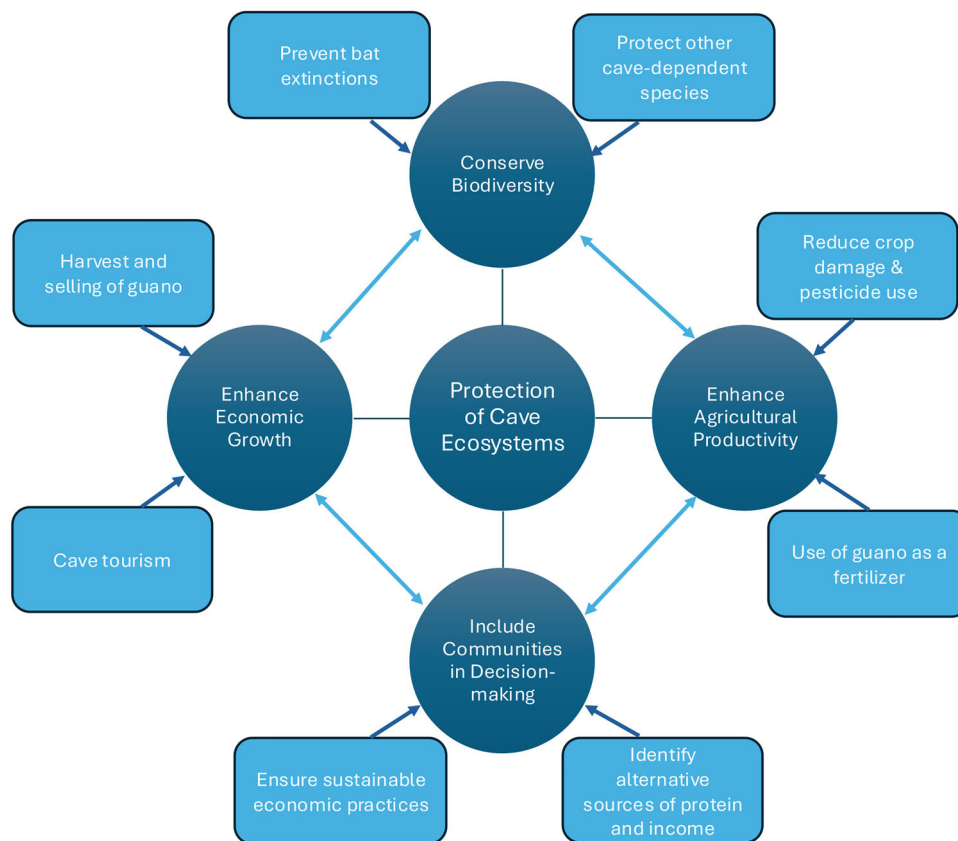


**FIGURE Box 1A** | Pathways by which bat conservation actions and ecosystem services specific for cave ecosystems align with targets from both the Global Biodiversity Framework (GBF) and the United Nations Sustainable Development Goals.

on identifying and implementing measures that effectively reduce bat fatalities at wind turbines is crucial for bat conservation globally (IFC 2023). This may initially appear contradictory to wind energy success, but minimizing bat fatalities at wind turbines while maximizing energy production would help wind energy become a more sustainable and scalable form of renewable energy, contributing to nine UNSDG targets (Table S2).

Although conservation measures can spark a cascade of socioeconomic benefits, sometimes short-term costs can occur in the process of achieving long-term goals. In some cases, communities reliant on hunting bats for consumption or income may experience short-term costs when transitioning away from this practice

to ensure sustainable long-term benefits. Responding to this conflict is crucial to conservation success and sustainability, and doing so also ensures that costs and benefits are not inequitably distributed across all parties (de Wit et al. 2022). Such responses involve co-creating integrative solutions with local communities by practicing active listening, trust-building, and bidirectional learning (Staddon et al. 2023). The co-benefits identified within the intricate linkages in a socioeconomic system can highlight valid ways to compensate those stakeholders facing short-term costs, transforming a potential conflict into a multi-faceted opportunity. For instance, transitioning to alternative sources of protein or income can mitigate conservation conflicts and reduce the risk of pathogen spillover (Plowright et al. 2024).



**FIGURE Box 1B** | Co-benefits of protecting cave ecosystems include conserving biodiversity, enhancing agricultural productivity, involving communities in decision-making, and fostering economic growth.

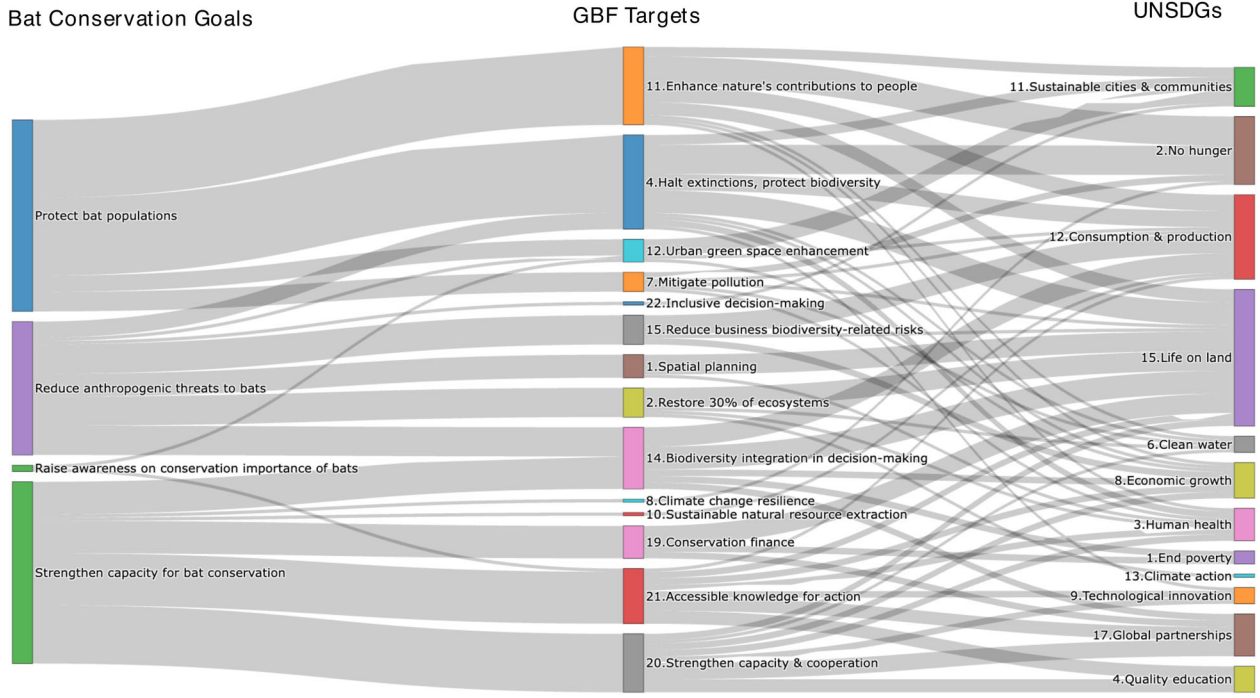
**Box 2: Bat-foraging habitats**

Protecting and restoring bat-foraging habitats is critical for maintaining healthy bat populations (Frick et al. 2024). Conservation actions can focus on protecting or ecologically restoring foraging habitats catering to some of the diverse foraging niches of bats (e.g., insectivorous, frugivorous, nectarivorous) (Frick et al. 2024). Such actions align with at least 14 GBF targets and contribute to at least 38 UNSDG targets focused on improving human well-being (UNSDGs 1, 2, 3, 4, 6), economic growth (UNSDGs 8), technological innovation (UNSDG 9), sustainable consumption and production (UNSDGs 11, 12), climate change mitigation (UNSDGs 13), biodiversity conservation (UNSDG 15), and international partnerships (UNSDG 17) (Figure Box 2A; Tables S1 and S2).

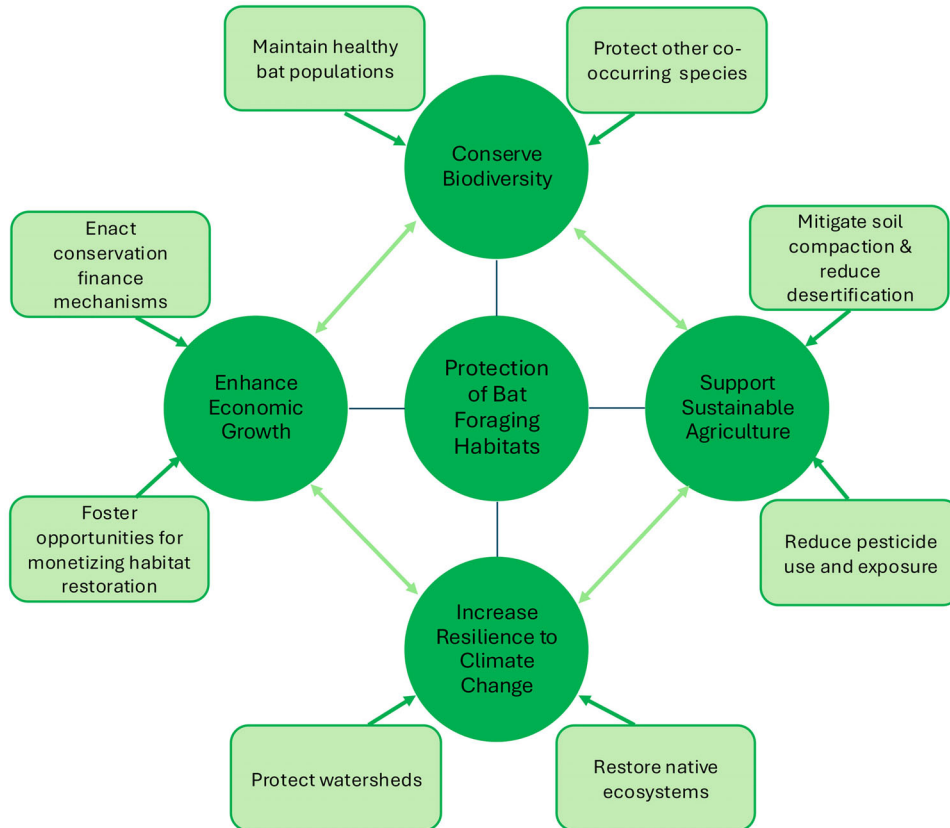
The protection of bat habitats often involves invasive species removal (GBF 6; UNSDG 15.8), exclusion of livestock to mitigate soil compaction and desertification (GBF 2; UNSDG 15.3), reforestation (GBF 1, 2; UNSDG 15.2), and watershed or natural springs restoration (GBF 2; UNSDG 6.6, 15.1, 15.2). Eighty percent of bats feed on insects, and protecting their foraging habitats involves bolstering their prey populations, which entails reducing pesticide usage in agroecological systems (GBF 7, 10; UNSDG 2.3, 2.4, 2.5, 3.9, 6.3) and creating insect habitats in urban settings, gardens, and residences; these efforts can also aid in combating global insect declines (GBF 4, 11, 12, 14; UNSDG 11.3, 12.2, 12.8) (Forister, Pelton, and Black 2019; Kawahara et al. 2021). Such actions not only serve to protect bat populations and the vital ecosystem services they provide (GBF 11; UNSDG 15.1, 15.2) (Table S1), but neighboring communities can also reap the downstream health, social, and ecological outcomes of these actions (Figure Box 2B; Tables S1 and S2). Benefits include agricultural resilience to climate change, carbon sequestration, flood risk reduction, reduced pesticide exposure, water purification, and improved water availability (GBF 2, 7, 8, 10; UNSDG 3.9, 6.3, 6.a, 13.2). In addition, protecting bat-foraging habitats can help reduce the risk of pathogen spillover (GBF 4; UNSDG 3.3) and foster financial mobilization through payment for ecosystem services programs and capacity-building initiatives (GBF 14, 19, 20, 21; UNSDG 1.4, 4.4, 11.3, 12.8, 17.3).

Introducing initiatives like preserving natural heritage sites, developing ecotourism activities, and employing community members as stewards could help offset costs. In addition, raising awareness about public health risks and implementing ecological

countermeasures to prevent spillover, such as protecting bat foraging sites and reducing human encroachment into bat habitats, offers a proactive approach to conservation that resonates with broader societal objectives (Plowright et al. 2024).



**FIGURE Box 2A** | Pathways by which bat conservation actions and ecosystem services specific for bat-foraging habitats align with targets from both the Global Biodiversity Framework (GBF) and the United Nations Sustainable Development Goals.



**FIGURE Box 2B** | Co-benefits of protecting bat-foraging habitats include conserving biodiversity, supporting sustainable agriculture, enhancing resilience to climate change, and fostering economic growth.



## 5 | Conclusion: A Species-Level Conservation Strategy

Understanding the intricate connections between bats, people, and their shared ecosystems is critical for effective conservation efforts. Bat populations, communities, and ecosystems each face serious challenges, and due to the abundant interactions and processes that connect their fates, species- or location-specific threats and challenges become shared concerns for the entire system. The processes that link these system components can be harnessed for sharing the positive impact of actions to overcome threats and meet challenging goals.

Bat conservation initiatives that align with MEAs, such as the GBF and the UNSDGs, can increase global awareness of bats' importance, increasing support for bat conservation and benefiting society at large. By explicitly articulating these connections, conservation programs can better address biodiversity and sustainability targets, amplifying their impact. This approach can be applied to any species-level conservation program. Species are the currency of biodiversity, and thus, pathways between species conservation goals, biodiversity targets, and sustainability targets are easily recognized, connected, and measurable. As species are part of socioenvironmental biological systems, the shared benefits span all levels of biological organization, including human society.

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### Acknowledgments

We thank Michael Daulton and Kevin Pierson for fruitful discussion and input on these ideas.

### Data Availability Statement

The data that supports the findings of this study are available in the Supporting Information of this article.

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### **Supporting Information**

Additional supporting information can be found online in the Supporting Information section.