Nature's Ledger:

Accounting for Decision Criteria in Conservation Finance (2015-2025)

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LIST OF ABBREVIATIONS

Collaboration for Environmental Evidence (CEE)

Multi-Criteria Decision Analysis (MCDA)

Non-Governmental Organization (NGO)

Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA)

Priority Threat Management (PTM)

Project Prioritization Protocol (PPP)

Research Information Systems (RIS) file type

Return on Investment (ROI) models

Sustainable Development Goals (SDG)

United Nations Development Programme (UNDP)

ABSTRACT

Conservation agencies must allocate scarce resources across competing ecological priorities, yet the criteria guiding these decisions are unevenly documented and often only implicitly justified. This systematized review synthesizes peer-reviewed studies published between 2015 and 2025 to identify the decision criteria used in conservation funding and prioritization frameworks. Searches conducted in Scopus and ScienceDirect, supplemented with AI-assisted retrieval, produced 104 records; after PRISMA screening, 32 studies were included in the final analysis. Three criteria families dominated the evidence base: ecological benefit, financial cost, and feasibility. These were operationalized through cost-effectiveness ratios, return-on-investment metrics, feasibility-adjusted benefit scores, and spatial optimization approaches. While a subset of studies incorporated ecosystem services, climate resilience, or species risk, few formalized social or governance dimensions such as equity, indigenous rights, or community-defined outcomes. This omission reveals a persistent transparency gap, as value-laden judgments continue to shape prioritization without being explicitly represented in models. The corpus also exhibited a strong geographic skew toward Australia, New Zealand, and North America. Despite a decade of global commitments emphasizing justice, resilience, and inclusive governance, conservation funding frameworks remain anchored in a narrow technical triad. Future tools must make value choices explicit and broaden criteria sets to better align funding decisions with contemporary conservation goals.

1. Introduction

1.1 Overview

Biodiversity conservation today unfolds within a landscape defined as much by ecological urgency as by the chronic financial instability that has shaped the field for decades. Conservation institutions—whether governmental agencies, non-profits, or large international non-governmental organizations (NGOs)—must allocate limited funds in environments where political expectations, donor influence, and institutional histories often hold as much sway as ecological science. Decisions about which species or ecosystems receive support do not occur in a vacuum; they are filtered through governance structures, organizational cultures, and entrenched value systems that shape what becomes visible, important, or fundable (Jacobson et al., 2010; Decker et al., 2017). Even as the global conservation sector increasingly frames itself as evidence-based, conservation priorities continue to emerge from a complex blend of scientific assessment and sociopolitical momentum, including long-standing tendencies to privilege charismatic wildlife, familiar landscapes, or countries aligned with donor preferences (Krause & Robinson, 2017).

Embedded within these institutional dynamics are the decision criteria, the explicit and implicit metrics that determine how "value," "benefit," and "risk" are interpreted. Whether a prioritization tool relies on cost-effectiveness calculations, multi-criteria trade-offs, or spatial planning models, it is ultimately the criteria that structure decisions and reveal which assumptions, values, and worldviews are being elevated. Yet research repeatedly demonstrates that these criteria are unevenly reported, inconsistently justified, and frequently shaped by forces external to ecological need, including political feasibility, public legitimacy, donor influence, and institutional identity (Adams et al., 2020; Mills et al., 2019). In practice, decision criteria

become the quiet architecture of conservation finance—the scaffolding that shapes ecological futures even when it remains largely invisible.

1.2 Research Gap and Rationale

Despite an expansive literature on conservation planning, surprisingly little work explicitly examines the criteria that underpin these decisions. Much of the scholarship evaluates the performance of prioritization frameworks or the ecological outcomes of funded interventions, but few studies interrogate the foundational assumptions embedded in the criteria themselves: what they measure, how they are chosen, whose values they represent, and which dimensions remain absent (Joseph et al., 2009). This gap matters because the structure of a criterion often determines the structure of the decision itself, shaping which trade-offs are visible and which alternatives appear preferable (Keeney & Gregory, 2005).

A growing body of research points to several ways that decision criteria may obscure more than they reveal. Studies of funding distribution have shown that conservation dollars often reinforce historical investment patterns, creating feedback loops in which previously funded regions appear more biodiverse and therefore continue to receive priority (Ahrends et al., 2011). Organizational ethnographies similarly demonstrate that conservation NGOs rely on cultural schemas and donor-facing narratives that privilege charismatic species and geographies, operating as de facto prioritization criteria even when they are never formally articulated (Krause & Robinson, 2017). At the institutional level, governance capacity, legitimacy, and public trust frequently shape which interventions succeed on the ground, yet these factors rarely appear in formal criteria despite their centrality to real-world decision-making (Jacobson et al., 2010; Decker et al., 2017).

Other strands of scholarship underscore the extent to which criteria reflect implicit worldviews about whose knowledge counts and whose interests matter. Community-based conservation efforts frequently falter when criteria require local populations to assimilate to externally defined models of nature or governance (Campbell & Vainio-Mattila, 2003). Environmental justice research likewise shows that technocratic approaches often overlook recognition and procedural equity, which remain largely unaccounted for in most conservation prioritization studies (Martin et al., 2013). Meanwhile, critiques of conservation practice identify what Gardner et al. (2018) call decision complacency—the tendency to invoke the language of evidence-based planning while relying on intuition, historical precedent, or organizational convenience.

Taken together, these insights reveal an urgent need for a synthesis that centers the criteria themselves. No existing review systematically compares the criteria used in conservation funding studies over the past decade or evaluates how those criteria reflect, obscure, or distort ecological need, social equity, governance realities, and institutional constraints. This study addresses that gap directly.

1.3 Research Aim and Objectives

Research Question:

How are conservation funding decisions made across published prioritization studies (over the time frame 2015–2025), and what decision criteria (explicit, implicit, or hidden) shape the allocation of limited conservation resources?

Objectives:

- Identify peer-reviewed studies (2015–2025) that allocate conservation resources and report the criteria guiding those decisions.
- Extract, categorize, and compare decision criteria across ecological, financial, feasibility-related, social, governance, and ecosystem-service dimensions.
- Examine how criteria are weighted, combined, or justified across different decision-support approaches.
- Assess transparency in reporting, including the visibility of weighting decisions, exclusion rules, and hidden filters.
- Evaluate geographic, methodological, and socio-political gaps in the evidence base.

1.4 Significance of Study

By shifting the analytical focus from prioritization frameworks to the criteria embedded within them, this study offers a clearer understanding of the underlying logics that direct conservation dollars. In a decade marked by global commitments to equity, indigenous rights, climate resilience, and sustainable development, examining how criteria encode values and shape trade-offs is essential for designing conservation finance systems that are transparent, legitimate, and resilient to political and economic volatility. This work provides a foundation for more accountable and inclusive decision-making by foregrounding the values and assumptions that determine the future of biodiversity conservation.

2. Literature Review

2.1 From Conservation Triage to Decision Science

Conservation decision-making has long been shaped by the reality that ecological need far exceeds available resources. Early debates framed this problem through the lens of "triage," prompting difficult questions about which species could realistically be saved and why (Bottrill et al., 2008). Yet these debates obscured a more fundamental issue: the opacity of the decision-making processes themselves. Over time, researchers recognized that the challenge was not simply biological scarcity, but the absence of transparent, structured, and defensible methods for allocating limited funds. This recognition catalyzed the rise of conservation decision science and the development of explicit frameworks for clarifying objectives and navigating trade-offs (Restani & Marzluff, 2002; Joseph et al., 2009).

Even so, technical advancements could not fully account for the institutional and governance systems that continue to shape conservation practice. Wildlife governance scholars note that many agencies still rely on paradigms formed decades ago (paradigms that center specific user groups, funding mechanisms, or governance expectations) and these institutional histories continue to dictate which priorities rise to the surface (Jacobson et al., 2010; Decker et al., 2017). Decision frameworks thus operate within environments that already contain powerful structural biases.

2.2 Framework Evolution and Expanding Criteria

Between 2015 and 2025, conservation prioritization methodologies diversified considerably. Cost-effectiveness approaches such as Project Prioritization Protocol (PPP) and Return on Investment (ROI) formalized relationships between threats, expected benefits, and

financial investment (Joseph et al., 2009). Multi-Criteria Decision Analysis (MCDA) approaches—ranging from Analytic Hierarchy Process (AHP) to outranking methods such as ELECTRE and PROMETHEE, as well as multi-attribute utility frameworks—introduced structured weighting across ecological, economic, and social dimensions (Adem Esmail & Geneletti, 2018; Huang et al., 2011; Velasquez & Hester, 2013). Spatial prioritization models further integrated connectivity, irreplaceability, and climate refugia, producing more nuanced spatial representations of conservation need (Brooks et al., 2006).

During this same decade, climate adaptation planning increasingly adopted MCDA because its explicit weighting, scenario-evaluation capacity, and treatment of uncertainty aligned well with the challenges of climate-impacted systems. MCDA was used to compare adaptation options under multiple future climate pathways, evaluate trade-offs between resilience and cost, and incorporate stakeholder preferences into decisions related to vulnerability reduction and long-term adaptive capacity (Ilori & Prabhakar, 2014; Watkiss et al., 2015; Bhave et al., 2016). These applications demonstrated how prioritization tools could move beyond static benefit–cost analyses toward adaptive, iterative decisions under uncertainty.

Despite these advancements, persistent blind spots remain. Governance capacity and institutional feasibility are rarely included as criteria despite their determinative role in implementation (Jacobson et al., 2010; Decker et al., 2017). Social and cultural dimensions (local knowledge, gender, indigenous governance, participation) are frequently acknowledged rhetorically but remain absent from the quantitative structures that drive actual decisions (Campbell & Vainio-Mattila, 2003; Martin et al., 2013). Organizational studies show that non-governmental organizations often rely on heuristics rooted in donor preferences, charismatic appeal, and organizational identity, shaping decisions regardless of formal methodologies

(Krause & Robinson, 2017). Funding analyses further reveal path dependency, in which historical investment creates the appearance of biodiversity importance, perpetuating geographic inequities (Ahrends et al., 2011).

2.3 What Are Decision Criteria?

Within any decision-support system, criteria determine which benefits, risks, and trade-offs are recognized. Drawing from decision theory, criteria can be understood as formal expressions of values, deliberate or implicit, that structure decision-making (Keeney & Raiffa, 1993). Over time, conservation has expanded its criteria from biological urgency to include cost, feasibility, ecosystem services, and climate adaptation (Gregory et al., 2012; Wilson et al., 2020). MCDA frameworks provide one mechanism for making these values transparent, typically through explicit weighting of criteria. In many MCDA approaches, these weights are developed with stakeholder participation, although the degree of stakeholder involvement varies by method and application (Adem Esmail & Geneletti, 2018).

However, criteria remain inconsistently defined. For example, feasibility may refer to ecological processes, governance stability, institutional capacity, or community acceptance—meanings that are rarely distinguished. Cost may reflect short-term expenditures, long-term maintenance, or opportunity costs, depending on the study. Many prioritization papers provide only limited justification for why certain criteria were selected while others were excluded, revealing what Gardner et al. (2018) describe as decision complacency: a reliance on familiar routines rather than deliberate reasoning.

2.4 The SDG/Paris Era (2015-2025)

The decade captured in this review coincides with a suite of global frameworks that placed unprecedented emphasis on climate resilience, social equity, and sustainable development. The adoption of the Sustainable Development Goals in 2015 and the Paris Agreement that same year reframed biodiversity loss as inseparable from climate mitigation, adaptation, and socio-economic justice (Pörtner et al., 2023). This momentum continued into the early 2020s with negotiations for the post-2020 Global Biodiversity Framework, formalized as the Kunming-Montreal Agreement in 2022, which explicitly called for more equitable, inclusive, and rights-based conservation practices, including recognition of indigenous governance systems and community land rights (CBD, 2022). Within this broader policy landscape, conservation discourse increasingly emphasized ecosystem services, indigenous stewardship, gender equity, and climate adaptation as essential components of effective biodiversity action (Martin et al., 2013; Campbell & Vainio-Mattila, 2003).

Yet this rhetorical shift did not consistently translate into operational criteria within prioritization frameworks. Community-based conservation programs often reproduced colonial assumptions by requiring local communities to conform to externally defined models of nature, participation, or governance (Campbell & Vainio-Mattila, 2003). Environmental justice scholarship likewise cautioned that distributive measures alone fail to capture deeper dimensions of recognition and procedural fairness—dimensions rarely operationalized in quantitative prioritization models (Martin et al., 2013). Funding patterns during this period also remained geographically uneven, with research and investment disproportionately concentrated in well-studied regions of the Global North rather than in biodiversity-rich but data-poor areas where ecological need is highest (Ahrends et al., 2011). In this way, the global conservation agenda

expanded normatively, embracing language around justice and equity, while operational criteria within prioritization frameworks often remained anchored in older assumptions rooted in ecological value, cost efficiency, and managerial feasibility.

2.5 The Politics of Criteria Selection

Despite their appearance of neutrality, decision criteria reflect political economies, institutional priorities, cultural schemas, and historical funding trajectories. Organizations decide which benefits matter and which risks are tolerable, often guided by donor expectations, public narratives, or governance systems grounded in particular worldviews (Krause & Robinson, 2017; Decker et al., 2017). Scholars of participation and environmental justice have long argued that technocratic decision-making can mask the exclusion of marginalized knowledge systems, particularly when criteria privilege Western scientific ontologies over indigenous or community-based understandings (Campbell & Vainio-Mattila, 2003; Martin et al., 2013).

These dynamics underscore why criteria must be studied directly. They are not merely technical components of a decision-support tool; they are the mechanisms through which conservation institutions articulate their values and, ultimately, determine whose ecological futures will be protected. This recognition forms the core of the gap this review addresses.

3. Methodology

3.1 Review Design and Rationale

This project employs a systematized review to examine how conservation funding priorities have been determined in the peer-reviewed literature between 2015 and 2025. A systematized review incorporates several components of a full systematic review—such as predefined search strings, transparent inclusion and exclusion criteria, and structured documentation—while allowing for methodological flexibility under conditions of limited personnel and time (Grant & Booth, 2009; Snyder, 2019). A full systematic review would have been the ideal methodological design; however, such reviews require multiple reviewers, double-screened records, extensive multi-database searches, and longer project timelines than are feasible within a single-researcher capstone project (Gough et al., 2017; Haddaway et al., 2015). Given these constraints, a systematized review represents the most rigorous and appropriate alternative, allowing for transparency, replicability, and conceptual depth while aligning realistically with available resources.

This approach is particularly suitable for the conservation-finance literature, which spans ecology, economics, spatial science, and environmental governance and rarely uses standardized terminology across studies. Research describing prioritization methods may use terms such as "optimization," "restoration targeting," "site selection," or "threat-management portfolios," even when these processes share common decision logics. A strictly systematic approach anchored to formal framework labels (e.g., "MCDA," "PPP," "ROI") would risk excluding relevant studies due to terminological inconsistency rather than substantive differences. Therefore, a central methodological choice in this review was to focus on decision criteria (such as cost, feasibility, ecological benefit, equity, or risk) rather than the named frameworks that authors employed. This

decision was grounded in the search protocol and inclusion criteria themselves, not in the choice of review type. By emphasizing criteria, the review captures how conservation funding decisions are justified in practice, regardless of whether authors explicitly assign their method to a formalized decision-support category.

The timeframe of 2015–2025 was selected to align with a decade defined by major global biodiversity frameworks and finance commitments. While the UN Sustainable Development Goals (2015) and the Paris Agreement (2015) influenced evidence-based environmental decision-making, the governance instruments most directly relevant to conservation funding were those under the Convention on Biological Diversity (CBD). The Aichi Biodiversity Targets (2011–2020) emphasized strategic prioritization, transparent target setting, and resource mobilization (CBD, 2010), while the Kunming–Montreal Global Biodiversity Framework (2022) renewed these commitments with an explicit focus on measurable outcomes, financing mechanisms, and equitable implementation (CBD, 2022). Limiting the review to this period therefore captures a decade in which conservation funding frameworks increasingly incorporated structured decision-making, ecological indicators, and climate-resilience considerations.

Because this review was conducted by a single researcher, double screening of abstracts and full texts was not possible, which is a known limitation of systematized reviews (Snyder, 2019). Double screening is standard in systematic reviews to reduce individual bias, ensure consistent application of inclusion criteria, and improve reliability. To mitigate these limitations, all screening decisions were documented in an extraction spreadsheet; inclusion and exclusion criteria were applied consistently across all records; and borderline cases were re-evaluated at least twice to ensure internal consistency. Detailed notes were recorded during both abstract and full-text screening, and exclusion reasons were explicitly logged to maintain transparency.

Although these procedures cannot fully substitute for independent double-screening, they provide a documented, reproducible record of decisions appropriate to a systematized review.

This review follows the PRISMA 2020 reporting principles for transparent research synthesis (Page et al., 2021) and the Collaboration for Environmental Evidence (CEE, 2018) guidance for documenting search strategies, screening outcomes, and inclusion decisions. Only peer-reviewed literature was included; gray literature was intentionally excluded to maintain consistent quality standards, reproducibility, and indexing reliability across all included sources.

3.2 Data Sources

Two scholarly databases, Scopus and ScienceDirect, served as the primary data sources for this review. Scopus was selected as the central database because it provides broad international coverage of environmental science, ecology, conservation planning, and decision-science research, and it supports complex Boolean search structures suited to multi-term conceptual categories (Falagas et al., 2008). ScienceDirect was included as a complementary database to ensure full-text coverage of Elsevier journals, which frequently publish research on MCDA, cost-effectiveness tools, ecological indicators, and prioritization frameworks used in conservation finance. While ScienceDirect overlaps with Scopus, its searches produced several non-duplicated articles that ultimately met the inclusion criteria and enriched the final corpus.

Additional databases were explored during preliminary testing but were excluded for transparent methodological reasons. Web of Science was not used due to institutional access limitations. JSTOR and Wiley Online Library lacked the Boolean flexibility required for multi-cluster search strings and returned large volumes of irrelevant engineering, infrastructure-

optimization, or general sustainability literature. Excluding these databases reduced noise while maintaining coverage appropriate for a single-researcher evidence synthesis.

A supplementary AI-assisted conceptual scan was conducted using Elicit (2025) to verify that the categories of decision criteria emerging from database searches (such as cost, feasibility, ecological benefit, socio-political considerations, and risk) were consistent with patterns identifiable in a broader algorithmically surfaced literature pool (Bernard et al., 2025). This step was used strictly for conceptual triangulation, not for article selection.

3.3 Search Strategy

The search strategy was developed through an iterative process of keyword generation, narrowing, and refinement, which was documented in two dedicated spreadsheets (Appendices A and B). This process reflects established guidance recommending pilot searches, iterative refinement, and transparent documentation in fields characterized by heterogeneous terminology (Grant & Booth, 2009; Haddaway et al., 2015; Pullin & Stewart, 2006).

The initial keyword list was compiled from influential literature on conservation finance and decision science (e.g., Naidoo et al., 2006; Joseph et al., 2009; Possingham et al., 2015; Adams et al., 2020) as well as from terms encountered during preliminary exploratory searches. These terms were grouped into conceptual clusters representing prioritization processes (“prioritization,” “optimization,” “decision support,” “site selection”), funding logics (“cost effectiveness,” “return on investment”), and ecological or feasibility dimensions (“biodiversity benefit,” “risk,” “feasibility”). Each cluster was tested through pilot searches to assess how different combinations influenced the ratio of relevant to irrelevant records.

The spreadsheets recorded the Boolean strings tested, the number of results returned for each iteration, the proportion of conservation-relevant articles, and notes explaining why particular terms were retained, removed, or modified. Several high-volume terms—such as "sustainable development," "ecosystem services," "nature-based solutions," and "environmental management"—were ultimately excluded from the core Boolean strings. Pilot tests revealed that these terms pulled in large bodies of general sustainability or valuation literature that did not involve prioritization, allocation, or decision-support processes. These concepts were therefore captured later as criteria categories during data extraction rather than used as search drivers.

The final Boolean strings represent the point at which further additions no longer improved relevance and instead reintroduced noise. This reflects best practices for constructing targeted, reproducible search strategies within the constraints of a systematized review.

3.3.1 Scopus Search

The final Scopus query reflects deliberate decisions about how to structure each conceptual cluster and how tightly to constrain it. The search returned 66 records, representing a manageable and highly relevant dataset. Figure 3.1 presents each component of the finalized query alongside the rationale for its inclusion.

Boolean Strings	**Justification**
TITLE (framework OR priorit* OR allocation OR "decision analysis")	Placing these decision-oriented terms in the TITLE field was a way to ensure that the paper's primary focus was on a decision problem or framework, not just a passing

	mention in the abstract or methods. The term priorit* was retained because pilot tests showed it efficiently captured prioritization, prioritising, prioritizing without introducing additional noise. Terms such as ranking or planning were tested in pilots and logged as generating too many general planning papers with no funding/criteria component, so they were ultimately dropped.
AND TITLE-ABS-KEY (conservation OR biodiversity OR ecosystem* OR "protected area*" or "habitat restoration")	This clause ties the decision focus explicitly to biodiversity conservation. The spreadsheet notes distinguished between narrower (e.g., protected area) and broader (e.g., ecosystem, biodiversity) terms; pilot tests showed that including both sets increased coverage of terrestrial, freshwater, and marine contexts without overwhelming the results with non-conservation environmental management papers. The term ecosystem* was retained after tests showed it pulled in ecosystem, ecosystems, ecosystem-based without adding substantial noise, while

	broader terms like environment or sustainability generated an unmanageable number of irrelevant hits and were therefore excluded from the final string.
AND TITLE-ABS-KEY ("Project Prioritization Protocol" OR PPP OR "return on investment" OR ROI OR "multi-criteria decision" OR MCDA OR "cost-benefit analysis" OR "optimization model" OR "decision support tool")	During refinement, framework-specific terms were trialed both alone and in combination. The narrowing spreadsheet captured that including only generic terms like decision support and optimization pulled in large numbers of industrial process and engineering optimization papers. By anchoring this clause in named frameworks and tools that are widely used in conservation decision-making (PPP, MCDA, ROI, etc.), you ensured that the query preferentially returned studies that actually implemented structured decision frameworks, not just mentioned “decision support” rhetorically. At the same time, keeping generic phrases such as “decision support tool” and “optimization model” ensured that novel or bespoke frameworks that did not label themselves as PPP or

	MCDA could still be captured if they were used in a conservation context. Although this review focuses on decision criteria rather than specific frameworks, these terms were intentionally included in the Boolean search. Framework names acted as methodological anchors that increased the likelihood of retrieving studies with explicit, extractable criteria and reduced noise from unrelated optimization fields (e.g., engineering, transport, manufacturing). Importantly, these terms functioned as filters, not inclusion rules: studies were included based solely on the presence of criteria and allocation decisions, not on whether they used a formal named framework. Including framework names therefore strengthened comprehensiveness and precision without constraining the conceptual scope of the review.
AND TITLE-ABS-KEY ("project prioritization" OR "funding allocation" OR	Pilot runs documented in the spreadsheet showed that without an explicit allocation

"investment prioritization" OR "resource allocation" OR "budget allocation" OR "conservation prioritization" OR "cost-effectiveness analysis")	clause, the search returned many methodological or theoretical decision-science papers that never actually allocated funds, sites, or actions. This clause was therefore added to force the presence of terms that indicate a real allocation or prioritization problem (e.g., choosing between projects, sites, or actions under budget constraints). Terms like “budget allocation” and “funding allocation” were retained because they reliably identified finance-facing conservation studies, while more generic phrases like “policy evaluation” or “management strategy” generated a high proportion of non-allocative policy papers and were dropped.
AND PUBYEAR > 2014 AND PUBYEAR < 2026	This reflects the 2015–2025 timeframe justified in Section 3.1 (alignment with SDGs/Paris and the contemporary evolution of decision-support methods). In the spreadsheet and search log, earlier tests without a date filter produced older PPP and

	cost-effectiveness work that fell outside the conceptual focus of the SDG/Paris era.
AND NOT TITLE-ABS-KEY (energy OR urban OR transport OR "waste management" OR manufacturing)	The exclusion terms were introduced only after the keyword-narrowing sheet documented repeated clusters of irrelevant records (particularly energy systems optimization, urban transport modelling, waste-management siting, and manufacturing process optimization) that used similar language (e.g., optimization, decision support, resource allocation) but had no connection to biodiversity conservation. Rather than tightening conservation terms (which risked excluding relevant ecological work), the string was altered to subtract these obviously non-conservation sectors via a NOT clause. The specific excluded terms correspond directly to those high-noise clusters logged in the spreadsheet.
AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "ch")) AND (	These filters operationalize two decisions: to focus on peer-reviewed, research-grade literature (articles and chapters) and to restrict

LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SUBJAREA , "ENVI"))	to the environmental sciences subject area. During pilot runs, leaving subject area unconstrained led to a larger influx of computer science, operations research, and engineering optimization studies. Limiting to SUBJAREA = ENVI preserved interdisciplinary environmental decision-science work (e.g., hydrology–ecology portfolios that were still about conservation) while removing the bulk of non-ecological optimization work.

Figure 3.1: Final Scopus Query Justifications

3.3.2 ScienceDirect Search

ScienceDirect's more limited Boolean functionality made it impossible to replicate the full complexity of the Scopus query. The search log therefore documents a simplified but conceptually aligned string:

- (conservation OR "biodiversity conservation") to maintain ecological focus;
- AND ("funding allocation" OR "conservation finance") to isolate studies addressing financial distribution;
- AND ("decision support" OR "multi-criteria decision") to ensure inclusion of structured decision-making tools.

Pilot tests demonstrated that this shorter string produced a manageable number of articles (n = 38) that overlapped substantially with the type of decision-support work identified in Scopus, while still capturing several non-duplicated Elsevier-hosted studies. As such, the ScienceDirect search was not an arbitrary simplification, but a database-constrained adaptation of the more fully articulated logic used in Scopus.

3.4 Screening, Data Management, and Coding Procedures

Search results from Scopus and ScienceDirect (n = 104) were exported in RIS and text formats and imported into Zotero for citation management and Excel for screening. Deduplication was conducted using automated DOI matching supplemented by manual fuzzy-title comparison to ensure that each record represented a distinct study. Deduplication is a critical step in evidence synthesis because repeated records can artificially inflate study counts, bias screening outcomes, and distort inclusion statistics. After removing duplicates, 96 unique studies remained.

A title and abstract screening phase applied the predefined inclusion and exclusion criteria (Figure 3.2). Each study was categorized as “include,” “exclude,” or “borderline,” with borderline records flagged for full-text inspection. This procedure yielded 49 articles for full-text review.

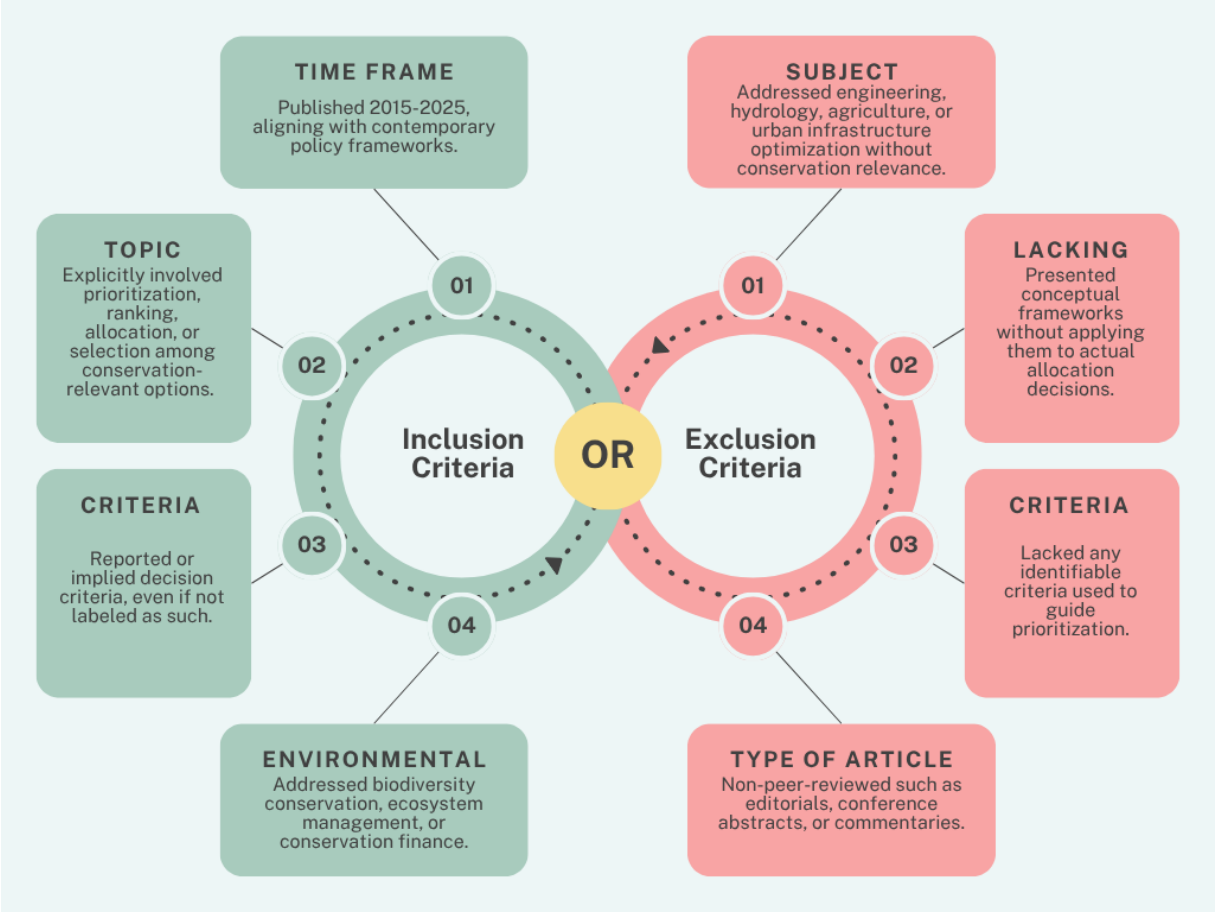


Figure 3.2: Chart Displaying the Criteria Used to Screen Articles for Full-Text Coding

Full texts were then coded using a structured matrix designed to extract the following information: study scale and region; conservation domain; the type of allocation or prioritization problem; explicit and implicit decision criteria; whether and how criteria were weighted; treatment of uncertainty, equity, social outcomes, or governance; and relevance to conservation finance. Coding emphasized criteria visibility rather than framework labels, reflecting the study's objective of mapping decision criteria rather than validating formal methodological typologies. These categories provided a standardized structure for assessing how criteria were articulated,

weighted, and embedded within decision-support processes. Because the coding matrix is central to the review's transparency and reproducibility, the core categories are defined in Figure 3.3.

Coding Category	Definition	Purpose in This Review
Study Region / Scale	Geographic location and spatial extent of the study (local, regional, national, global).	Establishes geographic patterns and identifies biases in representation across the final corpus.
Conservation Domain	The ecological or management context (e.g., species prioritization, habitat restoration, protected areas, threat management).	Clarifies the substantive conservation problem being addressed.
Allocation / Prioritization Context	The type of resource-distribution problem (e.g., budgeting, cost-effective management portfolios, spatial prioritization).	Identifies how financial or strategic allocation needs are framed.
Explicit Decision Criteria	Criteria clearly stated by authors as part of the selection or ranking process (e.g., cost, feasibility, biodiversity benefit).	Forms the core data used to map decision criteria across the corpus.

Implicit Decision Criteria	Criteria not explicitly labeled but identifiable through model structure, decision rules, or variable inclusion.	Ensures criteria embedded in methods (e.g., species distribution data, threat severity) are captured.
Weighting Practices	Whether criteria were weighted, how weights were applied, and who assigned them (experts, stakeholders, authors).	Helps assess transparency, value judgments, and methodological structure.
Treatment of Uncertainty / Risk	Inclusion of sensitivity analysis, scenario analysis, probabilistic modeling, or risk thresholds.	Indicates whether uncertainty influenced criteria choice or prioritization outcomes.
Equity / Social Outcomes / Governance	Any inclusion of social justice, community benefits, indigenous involvement, or governance capacity.	Captures whether frameworks incorporate non-ecological dimensions of decision-making.
Ecosystem Services or Climate Considerations	Whether ecosystem services, climate risks, or resilience metrics were part of the criteria.	Tracks alignment with global conservation finance priorities (e.g., Aichi Targets, SDGs, Kunming-Montreal Framework).

Relevance to Conservation Funding	Assessment of whether the study informs budgeting, resource allocation, cost-efficiency, or finance decisions.	Ensures inclusion is restricted to studies directly tied to conservation funding logic.

Figure 3.3: Definitions of Full-Text Coding Matrix Categories

These categories formed the backbone of the coding process during full-text review and ensured consistent extraction of criteria, weighting practices, and allocation logics across all included studies. The definitions in Figure 3.3 clarify how interpretive boundaries were set and how criteria were identified, especially in cases where authors embedded decision logic in model descriptions rather than stating it explicitly.

3.4.1 Rationale for Retaining an Empirical Outlier (Study S001)

Although Study S001 (Adem Esmail & Geneletti, 2018) differs from the rest of the corpus in that it synthesizes two decades of MCDA applications rather than presenting a single, bounded prioritization case study, it was intentionally retained due to its substantive relevance to the aims of this review. While S001 is an empirical outlier in terms of study design, it offers a uniquely comprehensive account of how MCDA-based conservation frameworks conceptualize feasibility, benefit, cost, and related criteria across methodological traditions. This broader analytical lens directly informed the development of the criteria categories used in the present study.

Excluding S001 on design grounds alone would have removed one of the few high-level analyses capable of contextualizing the heterogeneity observed across the 2015–2025 corpus.

Moreover, systematized reviews—unlike full systematic reviews—allow the inclusion of conceptually significant studies that enhance analytical clarity even when they fall outside the dominant empirical pattern, provided the rationale is transparent. Retaining S001 therefore strengthens both the interpretive depth of the criteria-mapping process and the methodological transparency of the review. Its inclusion was explicitly documented to avoid the unacknowledged "cherry-picking" that can occur when outliers are silently discarded. In this context, S001 does not function as noise but as an anchoring reference point against which more narrowly scoped studies can be compared.

3.5 Methodological Transparency

This review followed PRISMA 2020 guidelines (Page et al., 2021) and the Collaboration for Environmental Evidence (CEE, 2018), with complete documentation of search strategies, screening outcomes, coding decisions, and exclusions. Every stage of the process was recorded in real time to maintain a transparent audit trail.

3.5.1 Documentation of Search Strategy Development

All Boolean strings, pilot searches, and keyword-refinement decisions were recorded in two Excel workbooks (Appendices A and B). Each entry documented the database used, the full search string, number of results returned, observed noise patterns, and the conceptual reasoning behind each modification. Following best practices for systematized reviews, each iteration aimed to reduce irrelevance while minimizing the risk of omitting substantively appropriate studies.

3.5.2 Decision Tracking and Screening Log

The screening log documented the screening category (include, exclude, or borderline), reason for exclusion (e.g., lack of a prioritization component), deduplication checks, database overlap, and interpretive notes for ambiguous cases. This ensured transparency in how judgments were applied and allowed borderline studies to be revisited consistently.

3.5.3 Full-Text Coding Transparency

Full-text extraction was guided by a structured coding matrix that incorporated interpretive notes explaining how implicit criteria were identified, particularly when embedded in model descriptions. Study ID numbers and extracted variables for each of the 32 final studies are provided in Appendix C.

3.6 PRISMA Flow of Literature Selection

The identification, screening, eligibility, and inclusion process followed a PRISMA-style structure (Figure 3.4).

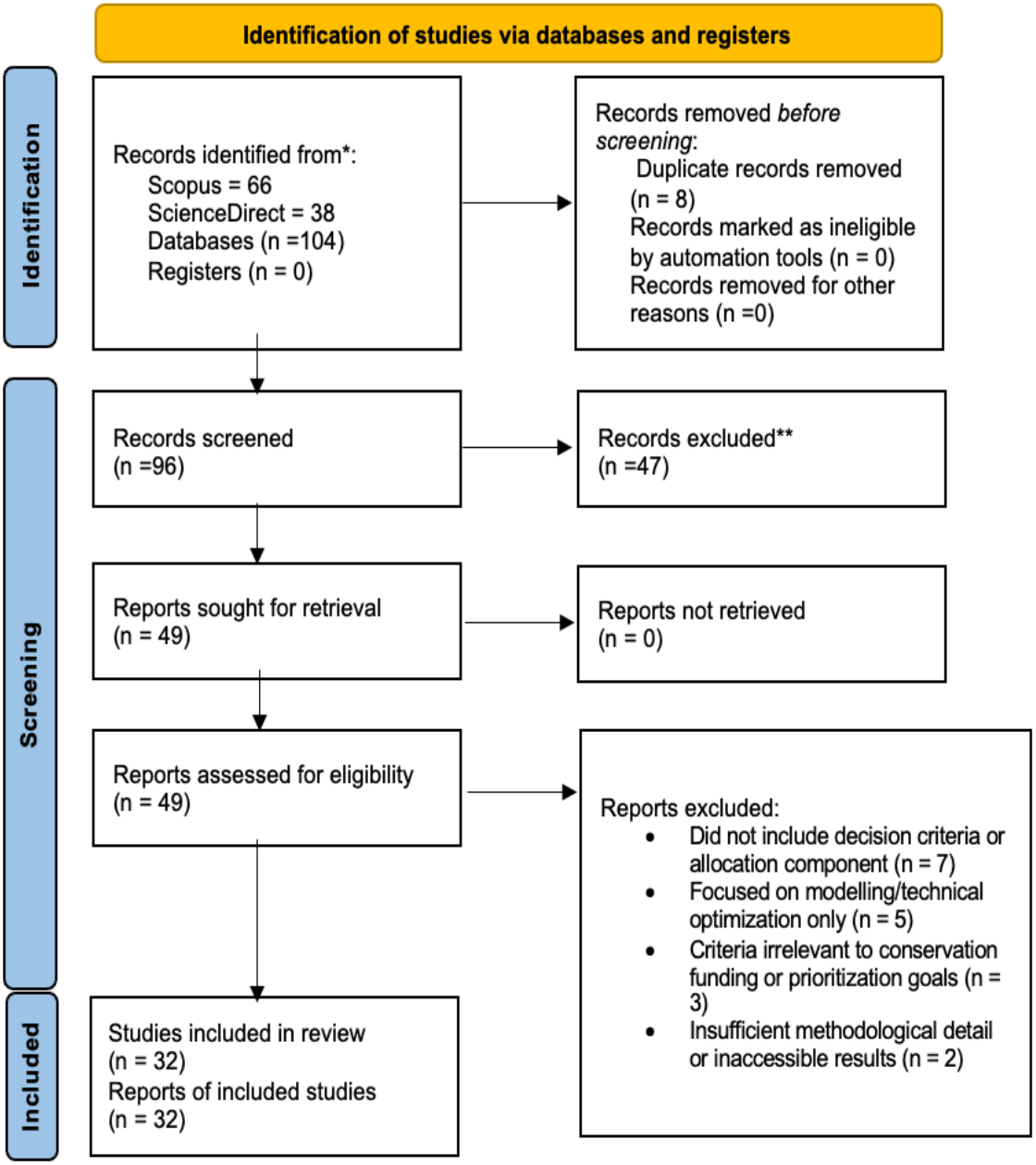


Figure 3.4: PRISMA Flow Chart

3.6.1 Identification

- Scopus: 66 records
- ScienceDirect: 38 records
- Total: 104 records
- Additional sources: 0

The AI-assisted Elicit scan did not contribute new articles but served as an external conceptual check, confirming that cost-effectiveness, feasibility, ecological value, and risk consistently emerged as decision criteria across broader machine-retrieved literature. This triangulation affirmed that the structured search strings captured the expected domain of prioritization logics.

3.6.2 Deduplication

Two-step deduplication removed eight records using automated DOI matching and manual fuzzy matching for non-DOI entries, resulting in 96 unique studies.

3.6.3 Title and Abstract Screening

Outcomes from screening 96 records:

- Included for full text: 49
- Excluded: 47

Exclusions were primarily due to lack of conservation relevance, absence of prioritization or allocation components, engineering or hydrological optimization focus, or purely conceptual frameworks lacking extractable criteria.

3.6.4 Eligibility (Full-Text Review)

Full-text screening excluded 17 additional studies due to lack of extractable criteria, absence of decision-making components, or methodological mismatch.

3.6.5 Inclusion

The final corpus consists of 32 studies.

3.7 Limitations

3.7.1 Geographic Bias

The final corpus is disproportionately weighted toward studies conducted in Australia, North America, and Europe. This pattern reflects broader structural biases in scholarly publishing, including differential funding availability, publication access, and institutional resources. Database indexing reinforces these disparities, resulting in underrepresentation of Global South and indigenous-led conservation models.

3.7.2 Limited Representation of Indigenous and Local Knowledge Systems

The review identified almost no peer-reviewed prioritization frameworks grounded in indigenous governance, customary law, or community-defined criteria. This gap reflects both the limitations of this study—restricted to English-language, peer-reviewed sources—and structural barriers that communities face in publishing academic research, such as financial costs, institutional requirements, and linguistic bias. Because many indigenous stewardship practices occur outside academic channels, future research could incorporate qualitative and ethnographic

methods, including interviews with elders, land stewards, and community conservation practitioners.

3.7.3 Language and Publication Bias

Restricting the review to English-language, peer-reviewed studies excludes non-English conservation prioritization frameworks and culturally specific decision systems that may not appear in major academic databases.

3.7.4 Exclusion of Gray Literature

Government reports, NGO documents, technical guidelines, and unpublished prioritization tools were excluded to maintain methodological consistency. However, many conservation funding decisions are shaped by non-peer-reviewed sources, meaning this review reflects academic discourse rather than the full spectrum of practice.

3.7.5 Systematized Review Constraints

As a single-researcher capstone project, this review used two databases, excluded gray literature, did not include double-screening, and did not conduct formal risk-of-bias scoring. Although transparency and consistency were emphasized, these constraints inherently limit comprehensiveness.

3.7.6 Criteria Visibility Bias

Criteria were extracted based on explicit statements or inferable model elements. Informal, unreported, or institution-specific criteria may therefore be underrepresented. This

review captures the published logic of prioritization frameworks rather than the full suite of political, cultural, or institutional influences shaping real-world funding decisions.

4. Results

4.1 Overview of Included Studies

The final corpus consists of 32 studies published between 2015 and 2025 that met the inclusion criteria of (1) allocating scarce conservation resources—financial, spatial, institutional, or monitoring capacity—among competing options, and (2) reporting the criteria used to guide those allocations, whether quantitatively weighted or qualitatively justified. Of these, 31 studies present applied or empirical prioritization frameworks, while one study (S001) is a methodological synthesis of MCDA practice and weighting logic rather than an allocation tool per se.

The 31 empirical studies span multiple spatial and decision-making scales:

- Species- or threat-management portfolios (n = 7): focused on threatened species, ranking of management actions, or reducing extinction risk (S003, S007, S013, S036, S038, S047, S049).
- Spatial allocation frameworks (n = 13): operating at landscape or regional scales to allocate land, restoration effort, invasive species treatments, or protected-area expansions (S010, S016, S019, S027, S033, S040, S041, S051, S054, S056, S057, D031, D032).
- Program- or system-level budget allocation tools (n = 3): distributing funds among wildland-fire programs, climate-impacted mountain regions, or policy-implementation barriers (S050, S035, D022).
- Financial and policy instruments (n = 4): including PES schemes, debt-for-nature swaps, cost–benefit economic frameworks, and ecological investment tools (D006, D021, S034, D023).

- Monitoring and implementation-design frameworks (n = 4): allocating resources among monitoring strategies, stakeholder-driven interventions, or feasibility-bounded choices (D026, S005, S043, D022).

Across these domains, a unifying pattern is the presence of explicit trade-offs: not all species, sites, actions, or governance options can be funded or implemented, and each study formalizes a set of criteria that determine which options rise to the top of a decision hierarchy.

4.1.1 Geographic Representation

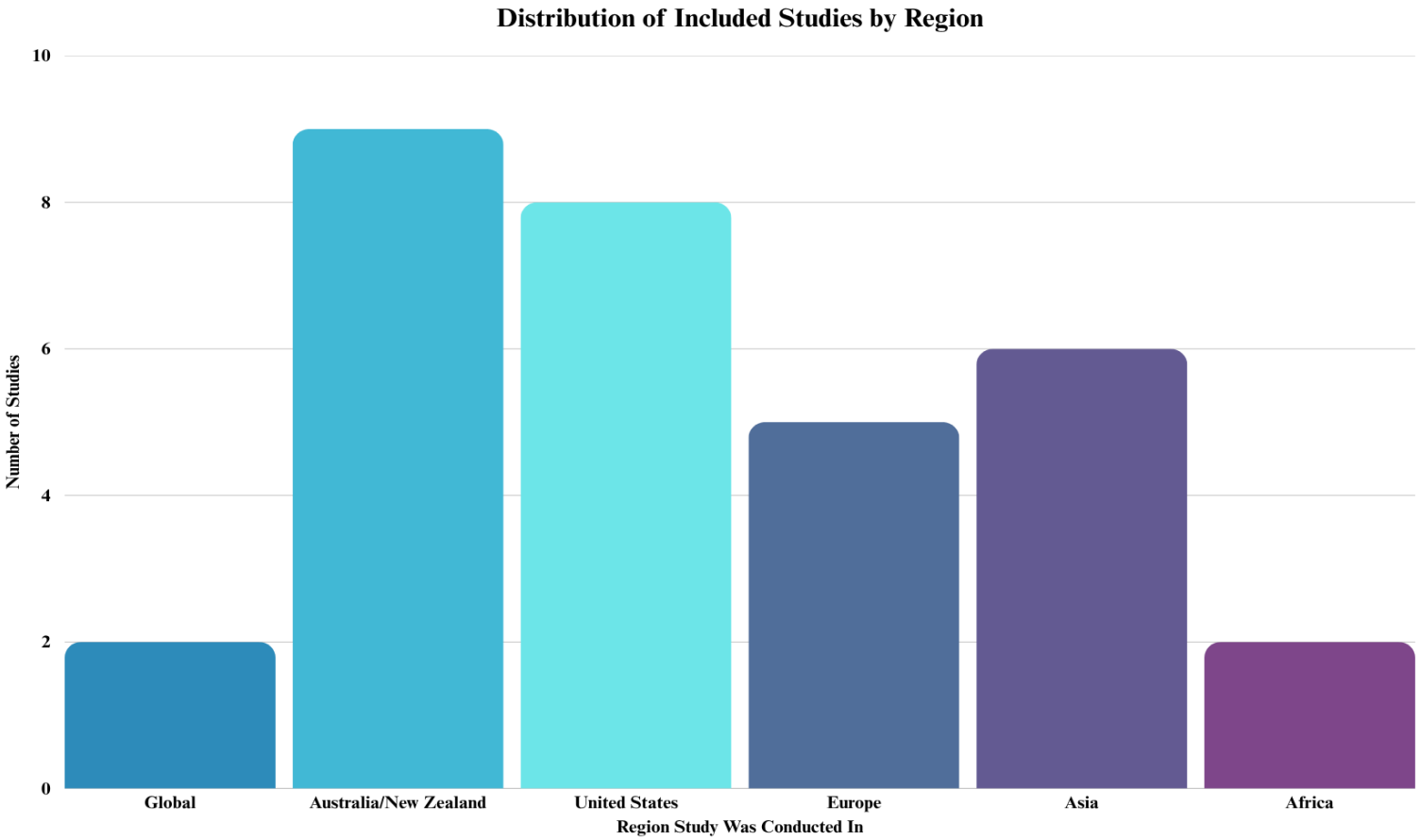
The 32 studies reveal a marked unevenness in regional representation. A clear majority (22 studies; 68.8%) originated from Australia, New Zealand, Europe, or the United States—reflecting the continued dominance of Global North institutions in the development and application of conservation decision-support tools. Within this set:

- Australia and New Zealand contribute 9 studies (28.1%), including nearly all PTM/PPP applications (e.g., S003, S007, S033).
- The United States contributes 8 studies (25%) in restoration, watershed planning, fire management, and land-use prioritization (S005, S016, S040, S041, S050, S051).
- Europe contributes 5 studies (15.6%), focused on Alpine ecosystems, brownfield planning, or large-scale biodiversity–ecosystem service mapping (D031, S033, S048, S057).

By contrast, the Global South accounts for only 10 studies (31.3%) despite containing much of the world's biodiversity:

- Asia contributes 6 studies (18.8%), including ecosystem-services prioritization in China (D006, D032), orangutan conservation (S036), and transboundary planning in the China–Myanmar hotspot (S019).
- Africa contributes just 2 studies (6.3%), covering a national-scale prioritization in Nigeria (S038) and a community-based monitoring MCDA from Madagascar (D026).
- The remaining 2 studies (6.3%) operate at global scales (D021, S006).

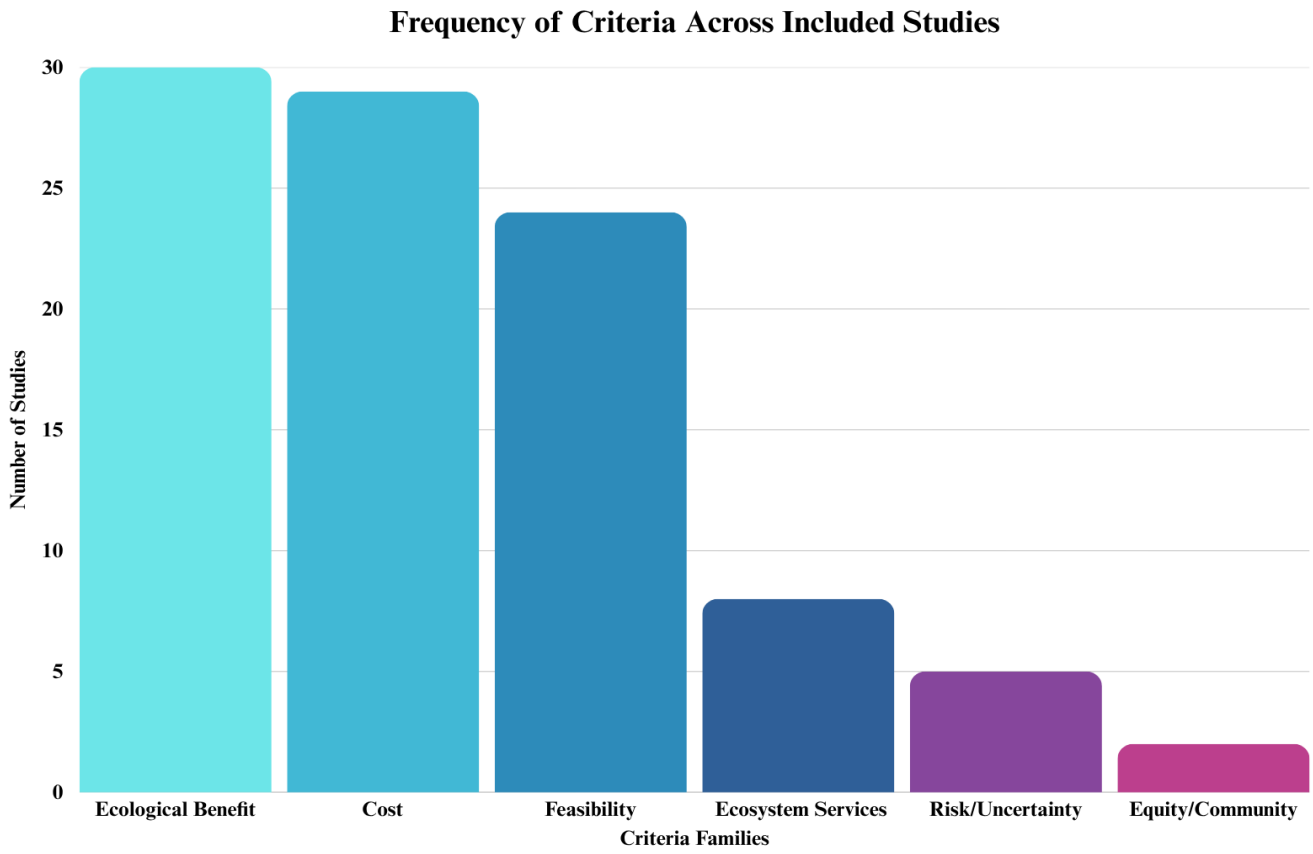
Although the corpus spans multiple ecological and governance contexts, the distribution is strongly skewed toward Western and high-income settings. Because geographic context shapes assumptions about feasibility, governance, and social equity, this skew has direct implications for the types of criteria that appear in prioritization frameworks. These implications are explored further in the Discussion.



Graph 4.1: Bar Graph Depicting the Number of Studies Per Region in the Corpus

4.2 Families of Decision Criteria

Despite variation in terminology and analytical detail, the criteria used across the 31 empirical studies cluster into six major families: ecological benefit, financial cost, feasibility and risk, ecosystem-service co-benefits, social equity and governance, and uncertainty. These families were identifiable across nearly all studies and provide the organizing structure for interpreting patterns of convergence and divergence in the corpus.



Graph 4.2: Bar Graph of the Identified Criteria Across the 31 Included Studies

4.2.1 Ecological Benefit and Biodiversity Value

Nearly all studies (30 of 31) included at least one explicit ecological-benefit metric. Species-focused studies commonly emphasized extinction-risk reduction or expected population response (S003, S007, S013, S036, S038, S047). Spatial and landscape studies prioritized habitat quality, connectivity, representation, or restoration potential (S016, S033, S040, S041, S054, S056, S057, D031, D032). A subset incorporated multidimensional biodiversity metrics such as functional or phylogenetic diversity (S006, S041). Only three studies quantified uncertainty in ecological outcomes (S039, S047, S049), though many acknowledged it qualitatively.

4.2.2 Cost and Cost-Effectiveness

Cost is the most pervasive non-ecological criterion, appearing in 29 studies. Direct implementation or maintenance costs featured prominently in species portfolios, invasive species treatment, and watershed management (S003, S005, S036, S039, S050, S051). Other studies relied on cost proxies such as land value, opportunity cost, or transaction cost (S019, S034, S054, D021). Eighteen studies combined benefit and cost in cost-effectiveness or ROI metrics, including orangutan conservation (S036), park-fire budgeting (S050), and various PPP/PTM applications (S003, S007, S013).

4.2.3 Feasibility, Risk, and Uncertainty

Feasibility appears in 24 studies but is defined inconsistently. Technical feasibility refers to staff capacity, infrastructure, or logistical complexity; socio-political feasibility covers stakeholder acceptance, public support, or regulatory alignment; and institutional feasibility

concerns agency mandates or governance structures. In some cases, feasibility serves as an eligibility filter that removes options before quantitative prioritization begins (e.g., S036, S040). Risk and uncertainty were explicitly modeled in five studies (S027, S039, S047, S049, D022), where demographic variability or probabilistic success was incorporated into optimization models.

4.2.4 Ecosystem Services and Co-Benefits

Ecosystem services appeared as explicit criteria in 8 spatial or landscape studies, often alongside biodiversity. These included carbon sequestration, water regulation, recreation, and agricultural production (S041, D031, D032). Some frameworks treated ecosystem services as additional benefit metrics, while others embedded them as parallel objectives in multi-objective optimization.

4.2.5 Social Equity, Community Outcomes, and Governance

Equity and community outcomes were rarely operationalized. Only two studies (D026, S043) incorporated social or community value as weighted criteria. A handful of others discussed governance capacity or institutional constraints (S038, D021, D022, S034) but did not include them in quantitative scoring. As a result, equity-based considerations remain largely absent from formal decision logic across the corpus.

4.3 Weighting and Trade-Off Structures

A central aim of this review was not only to identify which criteria appear across conservation-allocation frameworks, but also to analyze how those criteria are combined,

weighted, and operationalized. Weighting determines the relative influence of criteria and ultimately shapes which species, sites, or actions rise to the top of a prioritization. Across the 31 empirical studies, weighting practices varied considerably in transparency, methodological detail, and justification.

4.3.1 Forms of Weighting Identified

Implicit weighting (18 studies)

Occurs when mathematical structure, such as a benefit–cost ratio, assigns equal weight to benefit and cost by default (S003, S007, S036, S050). Only five studies explicitly justified the use of a benefit–cost formulation (S003, S007, S036, S050, D023).

Structural weighting (13 studies)

Common in spatial frameworks where biodiversity objectives dominate the optimization function and cost or feasibility appear as constraints rather than co-equal criteria (S033, S040, S054, S056, D031, D032). Only three studies documented how biodiversity indices were scaled or combined before optimization (S033, S041, D031).

Explicit weighting (4 studies)

Only four studies used formal MCDA with explicit weight assignment (S001, S010, S043, D026). Procedures varied and documentation was uneven. D026 provided the clearest protocol, comparing community- vs. science-driven weights. S043 documented stakeholder involvement but not sample characteristics; S010 used expert-derived weights without detailing elicitation. S001 reviewed but did not apply weighting empirically.

No study reported negotiated or contested weights, and only two (S001, D026) conducted sensitivity analyses.

4.3.2 Transparency in Weighting Procedures

Reporting quality was limited across weighting types:

- Studies documenting who selected weights: 3
- Studies documenting how weights were elicited: 2
- Studies comparing alternative weight sets: 1 (D026)
- Studies performing sensitivity analysis: 2 (S001, D026)
- Studies reporting negotiated or contested weights: 0

The absence of procedural transparency makes it difficult to determine whose values are embedded within the criteria structure.

4.3.3 Weighting in Specific Framework Types

ROI, PPP, and PTM models

These frameworks treat weighting as inherent to the benefit–cost equation, with feasibility sometimes incorporated as a modifier or eligibility constraint.

Spatial prioritization

Weighting is embedded in biodiversity indices, cost layers, and representation targets. None of the spatial studies used stakeholder-derived weights.

Risk-sensitive weighting

A small subset incorporated risk aversion or probabilistic uncertainty (S047, S049, S027, D022), though risk was rarely conceptualized as a weighted criterion.

4.4 Transparency in Studies and Reporting Quality

Across the 31 empirical studies, transparency in reporting varied dramatically. The clearest and most fully documented frameworks tended to be PTM and PPP applications, which explicitly defined their benefit, cost, feasibility, and (in some cases) complementarity criteria. Studies such as S003, S007, S013, S036, and S038 provided detailed scoring tables, documented decision rules, and presented transparent equations or benefit–cost formulations. Several of these papers also offered reproducible tools or open-source scripts (S049, S050), making their criteria structures highly visible.

MCDA-based studies generally reported their criteria lists and, in some cases, described stakeholder involvement or expert elicitation procedures (S001, S010, S038, S043, D026). However, even within this group, transparency was inconsistent. A few papers used stakeholder-driven weighting but did not provide information about the number of participants, how consensus was reached, or how weights were derived (S043). Others reported expert weighting without describing elicitation protocols (S010). Only D026 provided a fully traceable weighting process, presenting alternative weight sets and demonstrating how they altered prioritization outcomes.

Spatial prioritization and optimization studies displayed the widest variation in transparency. Some papers provided complete descriptions of objectives, constraint structures, cost layers, and biodiversity indices (S033, S041, S054, S056, S057, D031, D032). Others

foregrounded algorithm performance, data sources, or scenario modeling, while leaving the rationale for including or excluding specific criteria largely implicit. In several cases, governance, feasibility, or institutional factors were discussed narratively but not integrated into the quantitative model (S034, D021, D022).

Taken together, these patterns indicate that while many frameworks aspire to transparency, the visibility of criteria—and the logic used to justify them—remains uneven. Specifically, documentation about how criteria were chosen, how they were scaled or combined, and whose values they reflect is often insufficient for replication or scrutiny.

4.5 Equity and Social Capital

Equity and social capital remain almost entirely absent from operational decision criteria across the corpus. Only two studies (D026 and S043) incorporated equity, social value, or community outcomes into their formal weighting structures. D026 stands out as the only study that explicitly contrasts community-based and science-based value systems, showing how different worldviews generate different prioritization outcomes. S043 includes stakeholder acceptance as a criterion but does not provide much information about how this value was elicited or whose perspectives were represented.

A small set of studies referenced governance factors—such as institutional capacity, trust, or political support—but these considerations rarely influenced quantitative scoring or optimization (e.g., S038, D021, D022, S034). Instead, they functioned as narrative context, acknowledged as important but not structurally embedded in decision logic.

This limited operationalization of equity-oriented criteria contrasts sharply with the global conservation discourse of the 2015–2025 decade, which repeatedly emphasized justice,

inclusion, and indigenous rights. The gap between rhetorical commitments and actual implementation is therefore stark. The findings suggest that conservation prioritization models continue to privilege ecological and economic logics, while social dimensions remain at the margins of formal decision-support systems.

4.6 Cross-Framework Patterns

Viewed through a criteria-centered lens rather than a framework-centered one, the corpus reveals striking structural convergence. Despite spanning continents, ecosystems, and methodological traditions, the included studies consistently rely on variations of the same foundational triad: ecological benefit, financial cost, and feasibility.

PPP, PTM, and ROI models operationalize this triad most explicitly through benefit–cost–feasibility formulations. In these approaches, cost and benefit are treated as mathematically co-equal, while feasibility modifies expected outcomes or narrows the decision space. These models thus embed weighting structurally, even when authors do not describe it as such.

MCDA frameworks, in theory, allow for more pluralistic and transparent weighting across ecological, social, economic, and governance dimensions. In practice, however, few MCDA studies fully realize that potential. Most include ecosystem services or risk alongside biodiversity, but only rarely integrate equity, governance, or indigenous perspectives. Weighting protocols, when provided, lack procedural depth, and alternative value sets are almost never explored.

Spatial prioritization tools embed the same benefit–cost–feasibility logics in mapped form. Biodiversity objectives typically dominate, while cost appears as a constraint or penalty.

Many spatial models incorporate climate resilience, connectivity, or representation, yet social and governance dimensions remain absent or peripheral.

Financial and policy instruments—such as PES, debt-for-nature swaps, and conservation investment frameworks—adapt the core triad to incorporate financial leverage, opportunity cost, or long-term returns. However, these tools also rarely embed participatory or equity-driven criteria, reinforcing similar structural tendencies found in other frameworks.

Across all framework types, then, three overarching patterns emerge:

1. The dominance of ecological benefit, cost, and feasibility:

   These criteria appear nearly universally and form the backbone of most prioritization structures.
2. Systematic underrepresentation of equity, governance, and community values:

   Despite their prominence in global conservation rhetoric, these dimensions remain largely unembedded in formal decision tools.
3. Convergence driven by mathematical design rather than deliberated value choice:

   Weighting structures are more often dictated by equations or model architecture than by transparent deliberation, negotiation, or stakeholder co-production.

These cross-framework patterns underscore the central empirical finding of the review: the field exhibits strong methodological sophistication but limited normative breadth. Conservation decision-support tools remain anchored in technical, efficiency-oriented criteria, even in a decade characterized by global commitments to justice, resilience, and inclusive governance.

5. Discussion

The findings of this systematized review reveal a conservation decision-science landscape characterized by a remarkable degree of structural convergence. Across the 32 included studies, ecological benefit, financial cost, and feasibility formed an almost universal triad, present in 96.9% of cases and fully operationalized in 87.5%, that served as the dominant architecture for allocating scarce conservation resources. Alongside this convergence, the review also exposes persistent structural absences: equity and justice criteria were nearly nonexistent; weighting procedures were seldom documented; governance filters frequently determined what was considered "feasible" before analysis began; and the evidence base remained geographically skewed toward Global North contexts, even though most global biodiversity resides in the Global South. Taken together, these patterns suggest that contemporary prioritization frameworks, while analytically sophisticated, operate within a narrow value space shaped by long-standing economic rationalities, governance assumptions, and epistemic traditions originating in the Global North.

5.1 Efficiency, Feasibility, and the Narrow Architecture of Contemporary Prioritization

The dominance of ecological benefit, cost, and feasibility reflects not merely a methodological trend but a long intellectual lineage. Economic rationalism has influenced environmental policy since the 1960s (Mishan, 1971), and foundational texts by Krutilla and Fisher (1975), Possingham et al. (2001), and later Moilanen et al. (2009) entrenched efficiency as a central organizing principle of conservation planning. The studies reviewed here reproduce this lineage: PTM and ROI frameworks repeatedly showed cost reshaping rankings even when biological urgency was high, echoing critiques that cost-effectiveness can overshadow ecological

imperatives (Bottrill et al., 2008; McDonald-Madden et al., 2008). Spatial optimization tools similarly treated cost as a hard constraint rather than a value dimension, reflecting decades of budget-bounded modeling (Stewart et al., 2013).

Feasibility, appearing in 75% of studies, functioned less as a decision criterion and more as a gatekeeping mechanism. Actions deemed politically sensitive, institutionally unviable, or socially contentious were excluded before prioritization began, aligning with scholarship showing that governance capacity and institutional constraints determine conservation options long before decision-support tools are applied (Redford et al., 2013; Evans et al., 2020). What appears technically neutral is thus built upon layers of institutional judgment, implicitly narrowing the decision space to interventions that fit existing governance regimes.

This shared emphasis on benefit, cost, and feasibility embodies an ethical and institutional logic rooted in efficiency, pragmatism, and implementability. As Adams (2024) notes, such models often project an aura of objectivity while concealing the normative choices embedded within them. Optimization models cannot replace the political commitment to adequately resource biodiversity protection. In practice, efficiency-centered frameworks risk being misinterpreted as evidence that reduced budgets can achieve the same outcomes, reinforcing austerity logics rather than addressing the underlying scarcity.

5.2 Systematic Absences

Just as notable as what is present in the literature is what is absent. Only two studies (6.3% of the studies analyzed) incorporated any socially grounded criteria, and none operationalized indigenous governance, customary law, relational values, or cultural significance. This absence persists despite decades of evidence that such values are central to

effective, legitimate, and durable conservation outcomes (Agrawal & Gibson, 1999; Martin et al., 2013; Sterling et al., 2017).

The contrast with global policy rhetoric is stark. Over the 2015–2025 decade, the SDGs, the Paris Agreement, and the Kunming–Montreal Global Biodiversity Framework placed unprecedented emphasis on justice, inclusive governance, and indigenous rights (Pörtner et al., 2023; CBD, 2022). Yet the prioritization frameworks in this review largely ignored these commitments. Even in Global South settings, such as Madagascar or Borneo, frameworks relied almost exclusively on ecological and economic criteria drawn from Global North decision-science traditions.

This gap is consequential because indigenous-managed lands contain a disproportionate share of the world's biodiversity (Garnett et al., 2018; Schuster et al., 2019), and long-term conservation success depends on legitimacy, co-governance, and community partnership (Ban et al., 2018). The absence of justice-oriented criteria reflects what Pascual et al. (2021) describe as the persistent failure to embed plural value frameworks into biodiversity policy and contributes to implementation challenges and local resistance.

These findings reinforce critiques that equity and justice are routinely invoked rhetorically but rarely operationalized in funding decisions (Pienkowski et al., 2021; Daronco et al., 2023). What remains missing is not a peripheral layer of optional considerations, but a set of values central to contemporary debates over conservation's purpose and ethics.

5.3 Hidden Criteria, Transparency Gaps, and the Politics of Weighting

A further theme concerns the prevalence of hidden or informal criteria. In more than half of the studies, political risk, institutional mandates, stakeholder conflicts, and donor constraints

shaped which actions or sites were eligible—yet these filters remained undocumented. Such backstage decisions align with political ecology scholarship showing that conservation choices are always shaped by socio-political realities, even when presented as technical optimizations (Holmes et al., 2017; Asiyanbi, 2018).

Weighting practices exhibit similar opacity. Across the corpus, only three studies documented who selected their weights, only two explained how weight values were elicited, and none reported contested or negotiated weights. This is striking given extensive evidence that weighting fundamentally shapes prioritization outcomes (Belton & Stewart, 2002; Marttunen et al., 2017). The Madagascar study (D026) illustrated that alternative value systems produce fundamentally different portfolios, underscoring that weighting is inherently political—not merely methodological.

Despite strong rhetorical commitments to equity and indigenous rights since the 1990s—and especially during the SDG/Paris and post-2020 biodiversity eras—this shift has not translated into the criteria used within the Global North studies dominating the evidence base. Institutions in Australia, New Zealand, Europe, and the United States have helped advance justice-oriented language in conservation targets, but none of the Global North studies in this review formalized equity, community governance, or indigenous rights as operational decision criteria. This disconnect reveals a discursive–technical gap: justice appears in policy language but remains absent from the quantitative and qualitative structures guiding actual funding allocation.

These transparency gaps call for greater scrutiny of decision-support tools, which often present themselves as neutral despite embedding unexamined assumptions about risk, feasibility, and acceptable trade-offs (Redford et al., 2018; Addison et al., 2017).

5.4 Geographic and Epistemic Asymmetries

The review also highlights a major geographic imbalance. Nearly 70% of included studies were conducted in Australia, Europe, or North America, while only 31% examined Global South contexts. This asymmetry is troubling because the Global South houses most of the world's biodiversity (Myers et al., 2000; Brooks et al., 2006; Orme et al., 2005) and includes large areas of indigenous-managed land with exceptionally high ecological integrity (Garnett et al., 2018).

This mismatch between where conservation tools are produced and where they are most needed reflects broader epistemic patterns. As Büscher and Fletcher (2020) and Ndlovu (2022) argue, conservation science continues to rely on Global North epistemologies that do not necessarily reflect Southern social, cultural, or governance realities. The findings of this review mirror this: even when studying Madagascar, Borneo, or Nigeria, most authors used criteria, assumptions, and value structures originating in Northern institutions.

Such frameworks may generate technically sound outputs but risk overlooking critical components of conservation practice, including customary governance, sacred species, communal tenure systems, and livelihood dependencies (Ostrom, 2009; Robbins, 2019). This "epistemic leakage" (Adams, 2024) results in conservation recommendations that appear rational within scientific models but misaligned with local social and cultural worlds.

5.5 Supplementary Synthesis

The AI-assisted semantic search conducted using Elicit retrieved 499 studies and synthesized 40 articles, revealing global patterns highly consistent with those identified in the manually screened corpus: cost, ecological benefit, feasibility, and risk remained dominant,

while equity and governance were inconsistently operationalized. This convergence strengthens confidence that the final corpus reflects broader trends in conservation prioritization.

At the same time, the Elicit synthesis surfaced governance- and finance-related scholarship not captured by database searches alone, highlighting a known limitation of traditional systematic review approaches: database filters and Boolean logic tend to privilege ecological and economic terminology while overlooking social-science contributions (Haddaway et al., 2022). Thus, while the Elicit scan validated the empirical patterns identified in this review, it also underscores the importance of expanding future evidence syntheses to include diverse search modalities. Figure 5.1 depicts the overlaps between Elicit and the original review selection.

Dimension	**Original Review**	**Elicit**	**Overlap**
Timeframe	2015–2025	2015–2025	Identical
Unit of analysis	Applied prioritization frameworks	Frameworks + donor/governance meta-studies	Partial
Criteria families	6 families (ecology, cost, feasibility, ES, risk, equity)	Same 6 families dominant	Strong
Methods	MCDA, spatial, ROI, PTM	MCDA, spatial, ROI, PTM	Strong
Governance emphasis	Rated as feasibility	Major driver	Thematic convergence

Stakeholder inclusion	Rare in corpus	Rare globally	Identical
Overall conclusions	Cost + feasibility > biodiversity	Cost + governance > biodiversity	Similar

Figure 5.1: Supplementary AI-Assisted Semantic Search Validation

6. Recommendations

The patterns identified across contemporary conservation prioritization frameworks make clear that decision criteria function as far more than technical components of optimization models. They operate as the quiet architecture of conservation finance, and in doing so, they illuminate the underlying values, institutional logics, and structural blind spots that shape how conservation is funded. The recommendations below focus on forward-looking improvements to criteria design, weighting practices, governance alignment, and methodological development, reflecting both the empirical findings of this review and the normative commitments embedded within global biodiversity policy.

6.1 Reframing Conservation Practice Beyond Efficiency

A central recommendation emerging from this review is the need to reaffirm that efficiency, while important, cannot compensate for structural underfunding. Optimization models cannot replace the political commitment to adequate resource biodiversity protection. In practice, efficiency-centered frameworks risk being misinterpreted as evidence that reduced budgets can achieve the same outcomes, reinforcing austerity logics rather than addressing the underlying scarcity. To avoid this misinterpretation, researchers and agencies should explicitly acknowledge the limits of efficiency-based reasoning in methodological documentation. Efficiency should inform decisions, not serve as a justification for shrinking budgets or as a substitute for sustained public investment.

Equally important is expanding the conception of value embedded within prioritization frameworks. Conservation planning must treat equity, justice, and indigenous governance as co-equal determinants of priority-setting—not as narrative add-ons or secondary considerations.

Allocation systems should formalize these dimensions within the criteria themselves, ensuring that distributional impacts, procedural fairness, and rights-based concerns shape the structure of decisions.

Improving transparency is also essential. Many frameworks embed normative assumptions within feasibility assessments, exclusion rules, and weighting choices without documenting them. Future prioritization tools must clearly articulate how criteria were selected, how feasibility was defined, what exclusions applied, and who determined the weights. Such transparency is foundational to accountability, public trust, and legitimacy.

A recurring challenge concerns feasibility. Many frameworks implicitly assume governance stability, institutional capacity, labor availability, and implementation readiness that do not exist in the field. This disconnect undermines the usefulness of otherwise well-designed portfolios. Prioritization tools should therefore incorporate indicators of political volatility, funding cycles, permitting delays, institutional turnover, workforce capacity, and enforcement challenges. Scenario-based feasibility analysis should become standard, coupled with early engagement of local governance bodies to ensure that feasibility reflects lived institutional conditions rather than idealized assumptions. Treating socio-political realities as integral to prioritization, rather than as post hoc barriers, will significantly improve the practical implementability of conservation investments.

6.2 Aligning Policy and Governance with Social-Ecological Realities

At the policy level, allocation systems must align with the values and commitments articulated in the post-2020 global biodiversity framework. This includes integrating equity, indigenous rights, co-governance, and climate resilience directly into prioritization criteria,

weighting schemes, and scenario modeling. These elements should not appear solely in contextual justification sections; they should influence the structure of allocation decisions themselves.

Institutional transparency must also become a standard expectation. Agencies, NGOs, and philanthropic funders often describe their allocation processes as technically neutral, even when political feasibility, donor priorities, and organizational mandates substantially shape outcomes. Clear reporting standards are needed to document the rationale for criteria choices, the weighting process, stakeholder engagement, and institutional constraints. This level of openness parallels transparency norms in public budgeting and democratic environmental governance and would significantly increase legitimacy and accountability.

At the funding level, both philanthropic and governmental institutions must broaden their metrics. Portfolios grounded solely in ROI-style reasoning or short-term ecological gains are vulnerable to climate variability, governmental instability, and community resistance. Incorporating climate adaptation readiness, land-tenure security, socio-ecological resilience, and community governance capacity into allocation systems will support investments that are both scientifically grounded and socially durable.

Finally, co-creation must be institutionalized, not treated as an optional enhancement. Criteria development and weighting processes that are co-defined with indigenous communities, local stakeholders, and rights-holders produce more legitimate, contextually grounded, and implementable conservation portfolios.

6.3 Advancing Research and Method Development

Future research should focus on enabling cumulative learning by developing a unified taxonomy of conservation decision criteria. The current fragmentation of terminology around benefit, cost, feasibility, equity, governance, and risk makes comparison across studies difficult. Establishing standardized definitions and conceptual boundaries would strengthen continuity across the field and help identify persistent gaps.

Methodologically, prioritization models must become more dynamic and forward-looking. Nearly all reviewed frameworks treated ecological and institutional conditions as static, despite mounting evidence that climate change, political transitions, market fluctuations, and demographic shifts increasingly determine conservation outcomes. Models should incorporate scenario analysis, dynamic feasibility metrics, and long-term risk assessments to ensure that portfolios remain robust under multiple plausible futures.

Incorporating social and governance indicators directly into modeling approaches is another essential step. Conservation landscapes are deeply shaped by institutional capacity, rights regimes, tenure patterns, and community legitimacy. Optimization frameworks must reflect these realities rather than treat them as external context. Participatory and community-driven MCDA frameworks offer a promising path forward, enabling criteria and weights to be co-developed with those most affected by conservation decisions. Such models are more likely to reflect local priorities, anticipate implementation challenges, and avoid project failure.

Finally, the use of AI-assisted semantic search in evidence synthesis should be expanded. These tools can reduce disciplinary blind spots and ensure that governance, finance, and social-science perspectives are not inadvertently excluded from future prioritization studies.

7. Conclusion

This systematized review of conservation prioritization frameworks (2015–2025) shows that while decision-support tools have grown more sophisticated, their core logic—and their blind spots—remain strikingly consistent. Across the 32 included studies, three criteria dominate almost every model: ecological benefit, financial cost, and feasibility. This triad provides analytic rigor, but it also narrows the value space of conservation by sidelining dimensions that cannot be easily quantified, monetized, or embedded within optimization structures.

Although recent frameworks increasingly incorporate ecological complexity—connectivity, climate resilience, ecosystem services, and risk—social dimensions remain largely absent from operational criteria. Equity, community participation, indigenous governance, and distributive outcomes are acknowledged rhetorically yet rarely formalized as inputs that shape prioritization. As a result, prioritization frameworks often project technical objectivity while embedding unexamined institutional assumptions about what is "feasible," "cost-effective," or "worth funding."

The evidence base itself is geographically uneven. Most frameworks originate from Australia, North America, and Europe, meaning that Global North assumptions about efficiency, optimization, governance stability, and data availability dominate the literature. Regions facing the greatest biodiversity pressures are underrepresented, reinforcing an epistemic foundation that does not fully reflect the contexts in which conservation decisions matter most. This geographic and epistemic skew has substantive implications: while the field has developed powerful tools for structuring trade-offs, it lacks the value plurality and procedural safeguards necessary for legitimate, durable decision-making.

The path forward is not simply to add additional metrics, but to broaden what counts as value within conservation finance. Stronger prioritization systems will require explicit documentation of who defines priorities, how criteria are weighted, what assumptions guide feasibility, and whose risks and benefits are considered. Integrating social, political, and ethical dimensions into the architecture of prioritization—not as narrative context but as operational criteria—will be critical for aligning conservation funding models with contemporary global biodiversity goals.

The overarching conclusion is that improving conservation funding frameworks requires a shift from technical optimization toward transparent, inclusive, and accountable decision-making. By revealing both the criteria that consistently structure investment and those that remain systematically excluded, this review provides a foundation for designing prioritization tools that are not only ecologically defensible but also socially legitimate and resilient in an era of accelerating ecological and financial uncertainty.

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Appendix A: Pilot Excel Scopus Searches

Keyword / Boolean String	**Conceptual Cluster**	**Pilot Test Notes (Noise vs. Relevance)**	**Action Taken (Kept / Removed / Modified / Repositioned)**	**Rationale**
(Conservation OR Biodiversity) AND (fund* OR allocat* OR invest*)	Ecological domain + funding terms	Returned 1.2M results; first page unrelated (open-source intelligence, species behavior). High noise, not decision focused.	Modified	Needed anchoring in decision frameworks; funding terms alone pulled in general finance + ecology noise.
(Conservation OR Biodiversity) AND (fund* OR allocat* OR invest*) AND (Framework OR Protocol)	Ecological domain + framework anchors	Still 449k results; many bio/genetic/engineering papers.	Modified	Framework terms alone not strong enough; needed criteria/decision terms + ecological constraint.
(Conservation OR Biodiversity) AND (…) AND (criteria OR decision OR equity OR resilience)	Criteria + decision-making cluster	219k results; business/social science papers dominated; ecology weak.	Modified	Needed to force ecological decision context; criteria terms too broad alone.
… AND (“decision criteria” OR criteria OR weight* OR “cost-effectiveness”)	Criteria specificity block	94k results; still dominated by social sciences; redundancy in OR groups.	Modified	Criteria block refined; signaling too broad; needed domain anchoring (ecology).

… AND (“Sustainable Development Goals” OR SDG OR Paris Agreement …)	Global policy / SDG era	54k results; big shift but still too many non-environmental papers.	Modified	Policy blocks helpful but insufficient; needed conservation-specific funding + framework fields.
(“conservation fund*” OR allocat*)	Funding mechanism cluster	Cutting “fund*” to “conservation fund*” removed irrelevant finance papers; 13k results.	Kept (Refined)	Major improvement in precision; excluded general financial optimization.
Removed biodiversity from first clause (“conservation” only)	Ecological anchor	4,572 results; significantly cleaner; ensured conservation centrality.	Kept	Conservation alone is sufficient domain anchor; biodiversity inflated scope.
TITLE-ABS-KEY(“conservation fund*” OR allocat*)	Field restriction	959 results; abstracts/titles now required to mention funding/allocations.	Kept	Enforces topical relevance; removes latent/implicit mentions buried in text.
Added TITLE-ABS-KEY(“decision criteria”)	Criteria requirement	257 results; criteria must appear in abstract/title.	Kept	Forces explicit criteria articulation; strengthens alignment with study aim.
Added TITLE-ABS-KEY for frameworks (PPP, MCDA, ROI…)	Framework anchor cluster	147 results; lost a key relevant article → too restrictive.	Removed	Frameworks should filter, not constrain inclusion; risked excluding non-labeled but criteria-rich studies.

Reintroduced broader conservation domain (ecosystem*, protected area, habitat management)	Ecological expansion	292 results; improved ecological representation.	Kept	Captures terrestrial, freshwater, marine contexts without over-expansion.
Excluded DOCTYPE: cp, ed, le	Peer-review filter	277 results.	Kept	Restricts to research-grade literature; aligns with PRISMA/CEE.
TITLE(framework OR priorit* OR allocation OR “decision analysis”)	Decision-problem anchor	Strongly improves relevance; removed “planning” and “ranking” (previously too noisy).	Kept with narrowing	Ensures the paper is about a decision problem, not just tangential.
Added NOT clause (energy OR urban OR transport OR “waste management” OR manufacturing)	Noise exclusion block	Eliminated engineering and optimization noise clusters.	Kept	Directly tied to spreadsheet notes: removes high-frequency irrelevant domains.
Limited subject area to ENVI	Subject area control	66 results (Scopus final).	Kept	ENVI preserved interdisciplinary environmental work while cutting engineering/OR noise.
Final query (TITLE + TITLE-ABS-KEY + ENVI + NOT + DOCTYPE filters)	Final composite string	61 results after removing AG/SOCI noise and doubling framework anchor.	Kept (Final String)	Optimal balance of precision + comprehensiveness;

				produces final corpus for screening.

Appendix B: Pilot Excel ScienceDirect Searches

Search Concept	Keywords Tested	Notes / Rationale	Final ScienceDirect Query Used
Conservation Funding Frameworks	conservation; funding; framework; prioritization; allocation; decision-making	ScienceDirect does not support nested Booleans as deeply as Scopus, so we simplified by using AND within concept clusters and OR across similar terms. This concept targets general literature on structured funding decisions in conservation.	(conservation AND funding AND (framework OR prioritization OR allocation OR decision))
Decision Science Approaches (PPP, MCDA)	MCDA; "multi-criteria decision"; PPP; “project prioritization protocol”; biodiversity; conservation	Initially attempted longer Boolean chains but ScienceDirect rejected complex nesting. The final version focuses on key decision-science frameworks used in funding allocation literature.	(("multi-criteria decision" OR MCDA OR "project prioritization protocol" OR PPP) AND (conservation OR biodiversity))
Economic Prioritization & Cost-Effectiveness	cost effectiveness; ROI; "return on investment"; priority setting; conservation finance	Tested economic terms individually and together. ROI searches were very noisy unless paired with conservation terms.	(("cost effectiveness" OR "return on investment" OR ROI) AND (conservation OR biodiversity OR "priority setting"))

Resilience & Climate-Linked Funding Criteria	resilience; “climate change”; conservation funding; adaptation	Many climate-resilience papers exist, so conservation + funding terms were used to restrict results to allocation-relevant content.	((resilience OR "climate change") AND (conservation AND funding))
Equity, Stakeholder Values & Social Criteria	equity; social values; stakeholder values; conservation; funding	ScienceDirect was sensitive to phrase-level AND/OR mixing, so this cluster remained simple. Targets frameworks integrating social or justice-based criteria.	(("equity" OR "social values" OR "stakeholder values") AND conservation AND funding)
Combined Comprehensive Search (final run)	All above term clusters combined with OR	Built after testing each cluster to overcome search limitations and maximize relevant retrieval. This is the query that produced the non-duplicated ScienceDirect corpus you screened.	(conservation AND funding AND (framework OR prioritization OR allocation OR decision)) OR (("multi-criteria decision" OR MCDA OR "project prioritization protocol" OR PPP) AND (conservation OR biodiversity)) OR (("cost effectiveness" OR "return on investment" OR ROI) AND (conservation OR biodiversity OR "priority setting")) OR ((resilience OR "climate change") AND (conservation AND funding)) OR (("equity" OR "social values" OR "stakeholder values") AND conservation AND funding)

Appendix C: Final Corpus Summary

StudyID	Title	Authors	Region	Key Criteria	Summary
D006	Payments for Ecosystem Services in Watershed Allocation	Niu et al.	China	ES value; water benefit; cost; stakeholder input	Allocates watershed conservation resources using PES valuation.
D021	Prioritizing Debt Conversion for Marine Conservation	Gjertsen & Niesten	Global islands/coasts	Financial leverage; governance; risk; ecological impact	Identifies countries offering highest conservation impact per debt conversion.
D022	Hurdles to Quantitative ESA Resource Allocation	Maguire et al.	United States	Feasibility; institutional capacity; uncertainty; political constraints	Explains structural obstacles to implementing prioritization tools in ESA decisions.
D023	Economic Costs and Benefits of Conservation Actions	Naidoo et al.	Global	Cost; benefit; opportunity cost	Framework for evaluating economic bases of conservation prioritization.

D026	Prioritizing Biodiversity Conservation Approaches in Nigeria	Akande et al.	Nigeria	Community value; ecological value; cost; feasibility	MCDA combining community and ecological priorities.
D031	Integrating Ecosystem Services in Alpine Conservation	Hanna & Albert	Alps (Europe)	Biodiversity; carbon; ES; recreation; cost	Integrates biodiversity and ES in spatial prioritization.
D032	Marxan + InVEST for Conservation Prioritization	Zhang et al.	China	Biodiversity; carbon; water regulation; cost	Combines InVEST + Marxan to rank protected area expansions.
S001	MCDA for Nature Conservation: A Review of 20 Years of Applications	Adem Esmail & Geneletti	Global	Ecological value; cost; socio-economic factors; feasibility; stakeholder weighting	Reviews 20 years of MCDA in conservation and identifies recurring criteria families and weighting practices.

S003	Prioritizing Multiple Management Actions for Threatened Marine Megafauna	Carwardine et al.	Australia	Benefit; cost; feasibility; complementarity	Uses PTM to rank threat-management actions for marine species under budget constraints.
S005	Agricultural Conservation Planning Framework: Financial and Nutrient Reduction Tool	Tomer et al.	United States	Cost; nutrient reduction benefit; feasibility	Identifies cost-effective watershed BMPs to maximize nutrient reduction.
S006	Multiple Dimensions of Biodiversity in Freshwater Prioritization	Hermoso et al.	Global freshwater	Functional, phylogenetic, taxonomic diversity; representation	Shows how biodiversity metrics affect freshwater prioritization outcomes.
S007	Integrating Complementarity into Priority Threat Management	Chadès et al.	Australia	Benefit; cost; feasibility; complementarity	Examines how interactions among threats/actions shift

					prioritization portfolios.
S010	GIS-Based MCDA to Prioritize Invasive Plant Treatment	García et al.	United States	Invasion risk; ecological impact; cost; feasibility	Uses MCDA + GIS to rank invasive plant control sites.
S013	Reframing PPP for Biosecurity Eradication	Kean et al.	Australasia	Eradication feasibility; reinvasion risk; benefit; cost	Adapts PPP to biosecurity with explicit risk and feasibility scoring.
S016	Prioritizing Restoration for Sagebrush-Associated Wildlife	Ricca et al.	United States	Habitat quality; restoration potential; connectivity; cost	Ranks restoration areas for multispecies benefits.
S019	Transboundary Conservation Priorities in China–Myanmar	Li et al.	China–Myanmar	Biodiversity; land-use pressure; rarity; cost proxies	Identifies priority sites in a complex socio-political transboundary hotspot.

S027	Software for Prioritizing Conservation with Probabilistic Information	Chadès et al.	Global	Risk; uncertainty; probability of success; cost	Decision-support tool showing how uncertainty affects prioritization.
S033	Seafloor Mapping in Marine Conservation Prioritization	Bryan et al.	Australia	Habitat complexity; species richness; spatial metrics; cost	Uses fine-scale benthic maps to improve marine prioritization.
S034	Financial Instruments for Ecological Restoration	Ghosh et al.	Global	Financial risk; governance; ecological impact	Assesses investment criteria shaping restoration funding tools.
S035	Politically Weighted Mountain Biodiversity Priorities	Diserens et al.	Europe (Alps)	Biodiversity; climate exposure; land-use change; political feasibility	Shows how climate and politics shift mountainous region priorities.
S036	Cost-Benefit Prioritization for Orangutan Conservation	Abram et al.	Indonesia	Benefit; cost; feasibility; threat severity	Ranks orangutan conservation actions using cost-

					effectiveness logic.
S038	Systematic Prioritization of Biodiversity in Nigeria	Ayo-Vaughan et al.	Nigeria	Benefit; cost; feasibility; stakeholder support	National-scale prioritization using MCDA under limited data.
S039	Invasive Species Control under Demographic Uncertainty	Bode et al.	Global theoretical	Risk; uncertainty; cost; expected benefit	Optimizes invasive-species control under uncertain population dynamics.
S040	Allocating Land for 30x30 Conservation Targets	Carver & Carver	United States	Biodiversity; land-use pressure; cost; targets	Iterative land allocation balancing biodiversity and human needs.
S041	Shorebird–Agriculture Trade-offs under Climate Change	Reiter et al.	California (USA)	Agricultural value; habitat value; climate risk; cost	Finds land configurations benefiting both agriculture and wildlife.

S043	MCDA Land Conservation Framework with Stakeholder Acceptability	Schwarz et al.	United States	Stakeholder acceptance; ecological value; cost; feasibility	MCDA incorporating local preferences into conservation ranking.
S047	Risk Aversion in Conservation Project Prioritization	Chadès et al.	Global theoretical	Risk aversion; variance; expected benefit; cost	Shows how risk preferences drastically alter priorities.
S048	Timbre Tool for Brownfield Regeneration	Bartke et al.	Europe	Environmental benefit; socio-economic benefit; cost; feasibility	MCDA for selecting brownfield sites for sustainable redevelopment.
S049	Prioritizing Conservation Actions with Probabilistic Tools	Runge et al.	Global	Probability of success; risk; cost	Software demonstrating uncertainty-sensitive prioritization.
S050	Budget Allocation Models for U.S. National Park Fire Programs	Belval & Thompson	United States	Risk reduction; cost; fire outcomes; feasibility	Compares alternative ROI-based budget allocation

					models for fire programs.
S051	Restoration Prioritization for Sagebrush Species	Ricca et al.	United States	Restoration potential; species benefit; cost	Identifies landscapes optimal for maximizing multispecies gains.
S054	Land Market Feedback in Protected Area Optimization	Kroetz et al.	United States	Cost; ecological value; market response risk	Shows how dynamic land markets reshape optimal conservation choices.
S056	Systematic Prioritization with the prioritizr Package	Hanson et al.	Global	Biodiversity; cost; constraints; representation	Explains prioritizr's logic and how criteria shape solutions.
S057	Integrating Ecosystem Services and Biodiversity in Planning	Verhagen et al.	Europe	Biodiversity; ES; cost; trade-offs	Analyzes how ES integration influences conservation outcomes.